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423
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REPORT OF OBSERVATIONS

OF

INJURIOUS INSECTS

AND

COMMON FARM PESTS

DURING THE YEAR 1890,

WITH METHODS OF

PREVENTION AND REMEDY.

FOURTEENTH REPORT.

BY

ELEANOR A. ORMEROD, F.R. MET. Soc., &c.

CONSULTING ENTOMOLOGIST OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND, AND HON.
MEMBER OF THE FARMERS' CLUB; HON. AND CORR. MEM. OF ROYAL AG. AND HORT. SOC.,
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ALSO

MEMBER OF THE ASSOCIATION OF OFFICIAL ECONOMIC ENTOMOLOGISTS,
WASHINGTON, U.S.A., &c.

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OF
INJURIOUS INSECTS

WITH METHODS OF
PREVENTION AND REMEDY
FOR THEIR ATTACKS TO
FOOD CROPS, FOREST TREES, AND FRUIT.

TO WHICH IS APPENDED A
Short Introduction to Entomology.

COMPILED BY
ELEANOR A. ORMEROD, F.R. MET. SOC., &c.
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WASHINGTON, U.S.A., &c.

SECOND EDITION.

LONDON:
SIMPKIN, MARSHALL, HAMILTON, KENT & CO., LIMITED.

—
1890.

[OVER.]

SPECIMEN OF ILLUSTRATIONS.



Common Cockchafer, larva, and pupa.

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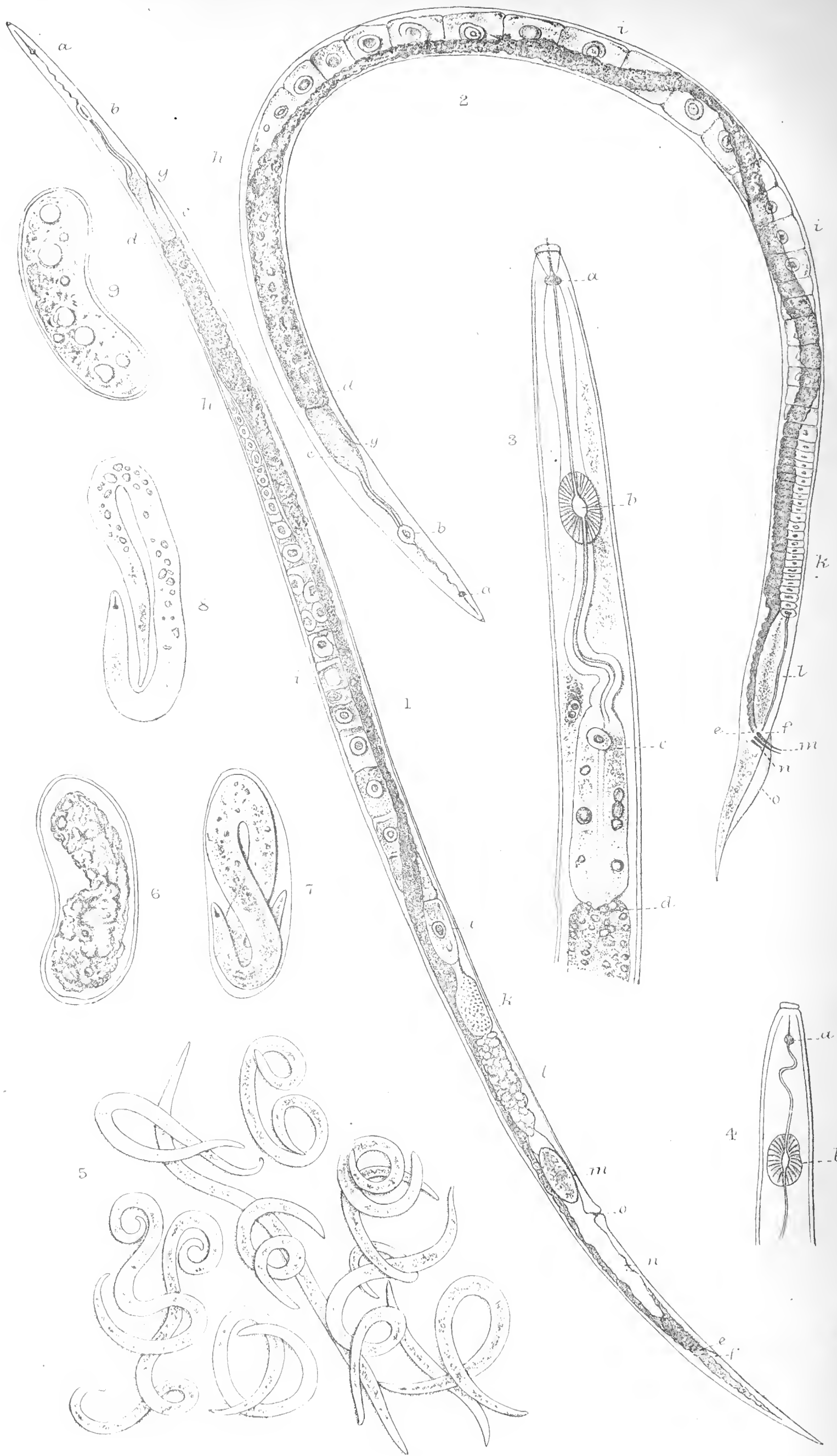
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[OVER.]





D. J. Ritzema Bos ad nat. del.

West, Newman lith.

Tylenchus devastatrix Kuhn.

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PREFACE.

DURING the past season of 1890, all, or almost all, of our common crop insect pests were present, and their ravages reported to a greater or lesser extent, but only a few as being seriously injurious, and none as causing wide-spread attack.

Amongst the crop attacks, which for various reasons are the most noticed, that of Hessian Fly has now become distributed at localities over most of the area of England, excepting the most southerly and westerly parts; but at the same time, as far as can be gathered from examination of specimens and from reports sent, the presence of the pest on the individual stalks of Wheat or Barley in the infested fields in the past year was slight, and the damage caused immaterial.

Whether from weather effects of our insular climate; or from autumn Wheat sowing being (when in regular course) after the time of autumn brood of the fly; or, again, from agriculturists being probably (in some cases) at the pains to destroy infested screenings; it is obvious that, after five years of presence in the country, this pest in its acclimatised condition, does not cause nearly as much mischief as other of our corn insects which unfortunately continue to ravage at their pleasure, because we have not yet found the missing link in their life-histories which would show us where and how they lie in our power.

Perhaps the chief among these are the Gout Fly maggot in Barley heads and stalks, and Bulb maggot in young Wheat, caused respectively by *Chlorops* and *Hylemyia* flies. These yearly cause much loss, and until we know where the maggots of the first spend the winter, and of the second spend the summer or autumn, we are without the clue to lead us to thorough preventive measures. This is a point on which observation is greatly needed for the public good.

The attack of Stem Eelworm (*Tylenchus devastatrix*), which some indications have pointed to for several years back as possibly occurring in Bean plants, has now been found to be unmistakeably present there, and stunting the growth to a serious extent.

Another species of Eelworm (*Aphelenchus fragariæ*), hitherto undescribed, has been found to be the cause of destructive malformation in Strawberry plant growth, which even if observed

before (which does not appear to have been the case on the scale of regular field attack) has not been recorded. Another somewhat similarly injurious attack to Strawberry plants from yet another kind of Eelworm is being watched; and these observations will be serviceable, by tracing what may have passed as a so-called "blight" to a definite cause, and probably definite cure.

Some of our common insect attacks were reported as severe locally; amongst these were Rust maggots to Carrots, also presence of Mustard Beetle and Mangold leaf maggot; Willow Beetle was seriously injurious. Orchard Moth Caterpillars, where remedial measures were not applied, also caused much loss.

The Mediterranean Flour Moth (*Ephesia kühniella*) has been steadily making good its hold in Wheat mills and stores in various parts of the country, and those who are suffering from it well know the serious loss as well as inconvenience caused by its all-pervading tenancy.

Some attacks were much less reported; amongst these were less enquiry regarding Turnip grub; and Turnip Green Fly also was only moderately reported. "Frit Fly" (*Oscinis frit*), an unusual trouble, of which the maggots did great damage in the bulbs of young Oats, especially in Devon and Cornwall in 1888; and Corn Sawfly (*Cephus pygmæus*), which is a very customary trouble, were hardly mentioned.

In the case of those of our ordinary crop attacks of which the history is now before us all, and preventive measures also up to date fairly well known (for which knowledge, it should be noticed, we are indebted in great part to the observations of our own agriculturists and fruit growers), I have thought it best not to continue to record merely notes of application for information where unaccompanied by any new observation of serviceable interest. Where any fresh information has been contributed, either of history, as in the case of observation of the winter state of *Chlorops* maggot, by Dr. W. Fream; or of a thoroughly practicable manurial treatment, as that to restore Mangold growth after leaf-maggot attack, with which I was favoured from Rothamsted, by kind permission of Sir John B. Lawes; or of notable absence or presence, or any point which may usefully be added to the *well-known* histories, I endeavour to record it. Otherwise, to avoid yearly repetition I am trying to bring forward observations of attacks not hitherto worked out, but which are of practical importance, and (of course) any which have not previously been noticed as present here.

Amongst these new or little noticed infestations, mentioned in my present Report, are the attacks of the American Clover-seed Midge, Mites in Hay, and distorted growth of Tares, and heads of Tares from one or more kinds of insect presence. Also, attacks of Chermes to Apple, and of the caterpillars of the Dot

Moth to Gooseberry and Currant; of those of the Fox-coloured Sawfly to Pine, and the very interesting observation (for which I am indebted to Dr. W. Somerville, Prof. of Forestry in the University of Edinburgh) of attack of our common "Pine Beetle" to Larch. Observations of Eelworm attacks to Bean and to Strawberry plants, and the peculiar malformed growths thence arising, have not been recorded before save in my official reports for the Journal of the Royal Agricultural Society of England, in which importance of space does not allow of full technical entomological details.

Great advance has been made in the past year as to the long-needed point of introduction of treatment which might be brought to bear when occasion called for it, in clearing off the hordes of moth caterpillars, which yearly, with the appearance of the spring leafage, had pretty much at their own pleasure ravaged the trees of our chief orchard growers. As full details of the means employed both for prevention and remedy, respectively, of autumn establishments and of spring injuries will be found under the heads of "Sticky-banding," "Paris-green," &c., it is unnecessary to do more here than to refer to them.

Advance has been made also in methods of applying insecticides, by introductions of new forms, and also by better adaptations of old forms of spraying machines, so that these are now procurable, suited as may be needed for the various requirements of orchard growth crowded by under-cropping, of more open space giving room for use of hand-barrow sprayer with much higher delivery up to 40 or 50 feet; or the Strawsonizer in its different forms for field and orchard use, of which the good report on its many trials as to delivery, both of dust and spray dressings, has been so often before us as to make it great matter of regret that the issue was so long delayed.

That advance has also been made in appreciation (in some of the highest quarters) of the necessity of adding knowledge of prevention of the ravages of crop insect pests to other branches of agricultural education, has been shown by the addition, in the past year, of agricultural entomology as a voluntary subject, to the papers set at the Senior Examination by our Royal Agricultural Society: also by examination on the same subject being now made compulsory at the Royal Agricultural College, Cirencester; and the subject is also receiving attention amongst the points of agricultural education which are especially taken up at the University College of N. Wales, at Bangor.

The endowment of a Lectureship in connection with the Chair of Agriculture in Edinburgh University, named, in remembrance of the liberal foundress, the "Steven Lectureship," has already in its opening course proved another helpful aid in advancement of serviceable knowledge of agricultural entomology. In the well

qualified hands of Dr. W. Fream, the course of instruction was throughout based on scientific principles, yet the practical applications of the subject were constantly kept in view. The requisite broad generalisations not being brought forward at first, but gradually worked up to and placed clearly before the agricultural students as the facts on which they were based accumulated, a trustworthy foundation was thus thoroughly impressed on the hearers for future work.

As in former reports it is my duty to offer my grateful thanks for important help afforded me in the past year's work. To our own agricultural press I have always to offer my thanks for valuable co-operation, and I have likewise gratefully to acknowledge the liberal and unceasing donations of successive publications with which I am favoured from Canada and various of our own Colonies, and likewise from the Dept. of Agriculture and Experimental Stations of the United States of America, which thus enable me to have at hand notes of the very latest advance in details bearing on prevention of insect crop and fruit pests.

To some of my kind and skilled fellow-workers my thanks are most especially due. Amongst them to Mr. J. Fletcher, the Dominion Entomologist of Canada, for great help given by his sound and experienced advice regarding application of insecticides for orchard use, and especially of Paris-green. To Dr. J. Ritzema Bos, Prof. of Zoology at the State Agricultural College, Wageningen, Netherlands, I am always indebted for his assistance with regard to identification, and also many other serviceable points regarding the history of nematoid worms, popularly known as Eelworms, which play an important part amongst the microscopic pests of some of our chief crops.

To Mr. Frazer S. Crawford, of Adelaide, S. Australia, whose sound and well-skilled work was so serviceable in his own Colony and so well and so widely known, my tribute of yearly thanks is now (with the regret for his loss shared by his many friends) a tribute also of respect to the memory of an earnest and thoroughly true worker who has passed to his rest. His careful observations, the zeal for the public good with which he was ever on the alert to prevent establishment of dangerous infestations in the Colony, the hearty courtesy and open-mindedness with which all points under discussion were conducted with the co-operators with whom he was in correspondence at home or abroad, make his loss cause of great regret to his colleagues and friends; and with a grateful remembrance of many years' unfailing assistance and co-operation, I desire to add my tribute of deep respect to his memory.

In the following Report, I have as far as possible mentioned the names of my co-operators with the subjects under consideration, but I have especially to acknowledge with many

thanks the assistance rendered me by Mr. Oliver E. Janson, F.E.S., of Perth Road, London, N., in identification or comparison of specimens, where I have not the opportunity myself of ascertaining these points with absolute certainty. To my sister also, Miss Georgiana E. Ormerod, F.E.S., I am always indebted for all the aid which constant colleagueship and no small amount of entomological knowledge can give.

The figures at pp. 27, 28 and 134, are given by permission of Messrs. Blackie & Son, Glasgow. Those at pp. 74, 77 and 78, by permission of Messrs. W. H. Allen & Co., London. Those at pp. 11, 113 and 122, from electros of which the use is permitted me for my Annual Reports, by the proprietors of the 'Gardeners' Chronicle.' Other figures which are copied, or in part taken from various entomological sources, are in almost every instance acknowledged accompanying, and the remainder, about 17 in number, have been drawn from life in some instances by myself, but for the most part by Mr. H. Knight, artist to Messrs. West, Newman & Co., London.

During the past season of 1890, in consequence of the heavy work requisite for the preparation of the 2nd Edition of my Manual, and the great injury to my health from the long continued over-pressure, I was not able to devote the time that I much wished to do to tracing out the full history of various attacks. But in the coming season, should moderate health be continued, and I am still favoured with the kind co-operation of my correspondents, I shall hope to give especial attention to investigation, and to be able as before in due season to submit to them again another Report.

ELEANOR A. ORMEROD,

*Consulting Entomologist of the Royal Agricultural
Society of England.*

TORRINGTON HOUSE, ST. ALBAN'S,

February, 1891.

LIST OF INJURIOUS INSECT AND EELWORM ATTACKS

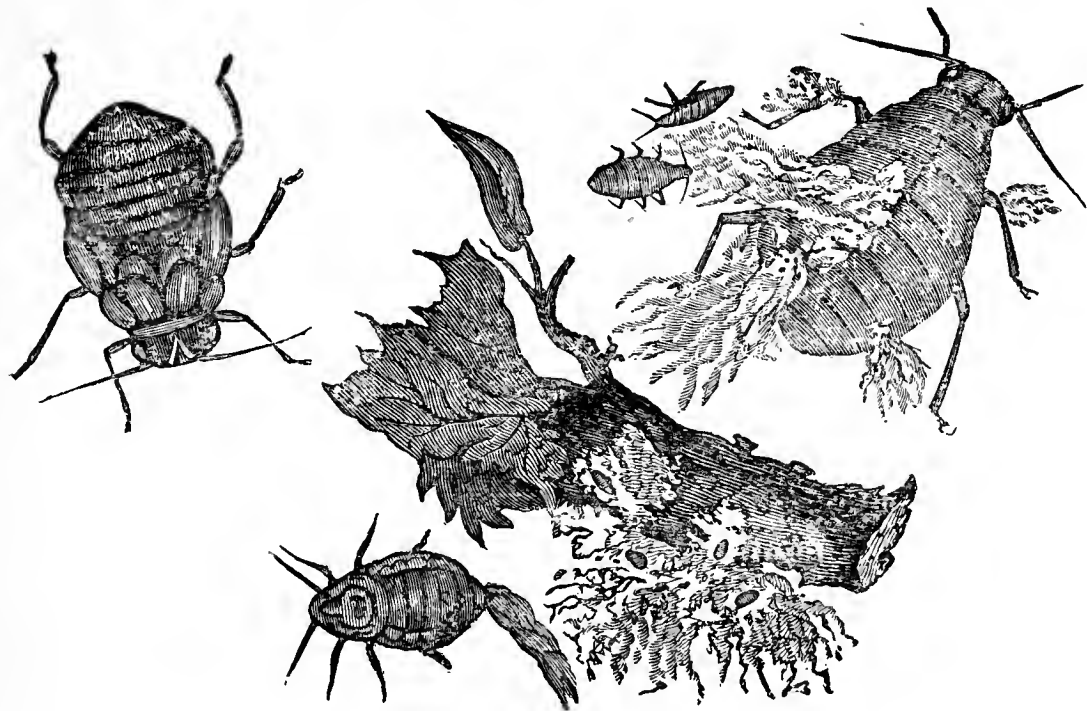
NOTICED IN THE FOLLOWING REPORT.

	PAGE
APPLE.	
American Blight	<i>Schizoneura lanigera</i> 1
Chermes	<i>Psylla mali</i> 4
Weevil (Apple-blossom).	<i>Anthonomus pomorum</i> 11
BEAN.	
Eelworm Blight	<i>Tylenchus devastatrix</i> 16
CLOVER.	
"Stem-sickness."	<i>Tylenchus devastatrix</i> 21
Midge (American Clover-seed)	<i>Cecidomyia leguminicola</i> 23
CORN AND GRASS.	
Gout Fly.	<i>Chlorops tæniopus</i> 28
Hessian Fly.	<i>Cecidomyia destructor</i> 32
Mites.	<i>Tyroglyphus longior</i> 40
"Tulip-root"	<i>Tylenchus devastatrix</i> 46
Wheat-bulb Fly	<i>Hylemyia coarctata</i> 49
FLOUR MILLS.	
Mediterranean Flour Moth	<i>Ephestia kühniella</i> 52
GOOSEBERRY.	
Dot Moth	<i>Mamestra persicariæ</i> 61
HORSE.	
Horse Bot Fly	<i>Gastrophilus equi</i> 64
MANGOLDS.	
Mangold (or Beet) Fly	<i>Anthomyia betæ</i> 72
ORCHARD MOTH CATERPILLARS.	
Winter Moth	<i>Cheimatobia brumata</i> 74
March Moth	<i>Anisopteryx æscularia</i> 77
Vapourer Moth (Common).	<i>Orgyia antiqua</i> 78
OX.	
Warble Fly	<i>Hypoderma bovis</i> 106
PINE.	
Pine Beetle (in Larch)	<i>Hylurgus piniperda</i> 113
Fox-coloured Pine Sawfly	<i>Lophyrus rufus</i> 118
Sirex	<i>Sirex gigas</i> 122
PLUM.	
Shot Borer Beetle.	<i>Xyleborus dispar</i> 124
STRAWBERRY.	
"Cauliflower Disease."	<i>Aphelenchus fragariæ</i> 126
TARES.	
Distorted growth	? <i>Insect cause</i> 134
WILLOW.	
Willow Beetle	<i>Phratora vitellinæ</i> 138

NOTES OF OBSERVATIONS
OF
INJURIOUS INSECTS
AND
COMMON CROP PESTS
DURING 1890.

APPLE.

American Blight; Woolly Aphis. *Schizoneura lanigera*, Hausm.



SCHIZONEURA LANIGERA.

Woolly Aphis; infested Apple spray, nat. size; wingless viviparous female and young clothed with cottony fibres, *above*, and small egg-bearing female, *beneath*, the spray; pupa, with slight cottony growth; all magnified.*

THE American Blight, or Woolly Apple Aphis, is an orchard-pest so widely distributed, and of such old standing, that it has seemed each year too well known to require special mention; but still, as the inquiries that recur show that its history and methods of prevention

* The above figure is acknowledged with thanks, as after 1 and 3, plate cv., and 2 and 5, plate cvi., in 'Brit Aphides,' vol. iii., by G. B. Buckton, F.R.S.

are not so well known as is desirable, and also the attack itself appears to be at times confused with other infestations, some short account of it may be useful.

The Woolly Apple Aphides are of the shape figured, with six legs, and (when in winged condition) with two pairs of transparent wings; a head furnished with antennæ or horns, and for the most part with a rostrum or sucking-tube, by means of which these insects cause great mischief. This rostrum is of enormous proportionate length in the Aphides when first born, but it is stated to be absent in the egg-laying female. The honey-tubes or cornicles are absent or rudimentary.

The colour differs with condition or sex, but the Aphides may be generally described as of some shade of brown in their older stages, and of warm brown or red or pinkish in their earlier condition. The winged egg-producing female is stated to be yellow, tinged with red. The pupæ are "slightly clothed with down. The insects, when adult, exude from their pores long silky threads, which curve round a centre, and often form long spiral filaments, under which they hide."—G. B. B. This wool sometimes shows merely as a film, like a little white mould in the crannies haunted by the plant lice; sometimes it shows as tufts and patches on the trunk or boughs, or on leaves, or on shoots,—anywhere, in fact, where the insects can establish themselves,—and in neglected gardens and orchards may be seen swinging in long partly detached masses. The existence of the attack may easily be known by the presence of these films or masses of white woolly matter, in which the insects shelter themselves, and the young may be found collected together thus even in severe cold. I have found them sheltered in the cottony material myself during the winter, and Mr. Buckton records finding the wingless larvæ alive and plentiful on Apple branches in December, when snow was on the ground, and the thermometer stood at 21° Fahr.

The mischief is begun by the Aphides inserting their suckers into the soft tissues of the trees, and drawing away the sap. They especially resort to where boughs or twigs have been removed, and the young bark is pressing forward over the wound, or where the outside bark may have been detached so that the Aphides can gain access to the soft surface beneath; and the result of the suction and many punctures is a soft pulpy swollen growth of the woody layers just beneath the bark. As time goes on these growths dry up and die, and crack open, and new colonies of Woolly Aphides, establishing themselves in the cracks, start new attack, and further diseased growth; and so the unhealthy mass continues increasing in size, until a tree which has been suffering from American Blight for several years is easily distinguishable by the knobbed and cankerous growths. The attack of the Woolly Aphis is also sometimes to be found on the roots as well as on the branches of Apple trees.

PREVENTION AND REMEDIES.—One great method of prevention is keeping the trees in such good order that no opportunity is given for the Woolly Aphides to effect a lodgment. For this purpose careful pruning and careful removal of all injured boughs, so as to leave as smooth a surface as possible, is very desirable. Scraping the trunks and larger branches in February, and then removing rough excrescences which would harbour attack in their crannies, has been recommended, the whole surface being well scrubbed afterwards with soft-soap wash.

In 1882, Mr. Malcolm Dunn, writing to me from The Gardens, Dalkeith Palace, N.B., mentioned:—"I find soft-soap an excellent insecticide, wherever it can be applied with safety to the plant; made into a thick lather and applied with a stiff brush to the stems of Apple trees infested with American Blight, it is a certain remedy. In the winter, when the trees are at rest, it may be applied all over the tree, and if the roots are uncovered from the base of the stem onwards as far as it is easy to get at them, and the soft-soap is applied to them also, the treatment will go far to stamp out the pest. Even a thorough soaking of the soil in which the roots run with strong soap-suds, repeated a few times during winter, is a first-rate means of keeping down American Blight. Of course, the soft-soap must not be applied (as above) to green leaves or bark; it is so caustic that it invariably burns them, especially if the sun strikes on the soap; therefore it must be used with caution in summer."

Probably the mixture known in South Australia as "Burford's soft-soap and sulphur compound" would be useful. This consists of soft-soap, to which one-fourth of its weight of sulphur is added—used as a wash for bark at a strength of 1 lb. to 1 gallon of water.

Any greasy or soapy mixtures, or resin mixed warm with fresh oil, or mineral oils used in soft soap, or, in fact, any application that will close up crannies and stifle or poison the Aphides, will be of great service, so long as care is taken that it does not injure the bark, or soak through it to the young tissues beneath.

Tar, which in former days was recommended, has been proved by the experience of late years to be excessively hurtful where it can soak into the bark; where soft-soap wash is to be applied to tender surfaces, it should be raised to boiling-point in the process of mixing to take away the caustic properties.

I have myself found that where there was water supply at command that thoroughly washing down the trees with a good stream sent through a spreader at the end of a hose had an excellent effect. The force and amount of application could thus be varied as needed, and, when the more delicate shoots were cleared, as powerful a stream as possible sent directly at the infested spots on the trunk and branches

acted thoroughly well in clearing them for some time, and the treatment can be repeated if needed.

The regular washes may also be very serviceably applied *by the help of powerful engines*. On June 23rd, Mr. Thos. Reader, of Old Hay Farm, Brenchley, wrote me :—"I have again been washing all my trees with a mixture per your direction, and have already found them greatly benefited. We use a horse-power machine, finding it impossible to get through the work any other way."

For prevention of American Blight the great points are clean and careful pruning, removal of all rough stumps of boughs or cankerous excrescences or torn and injured bark, which may harbour the blight beneath them, and keeping careful watch for the very first signs of appearance of Aphides, which may be easily known by the white wool.

The kinds of applications that will destroy them are endless, and little, if any, additional information has been brought forward (or, indeed, has appeared to be needed) for the last few years as to treatment, excepting, perhaps, as noted by Mr. Reader, the use of horse-power for throwing the applications; but as both in the past and present year some inquiry has been made regarding the attack, and the history has not previously been entered on in this series of Reports, I have given the main points as shortly as possible.

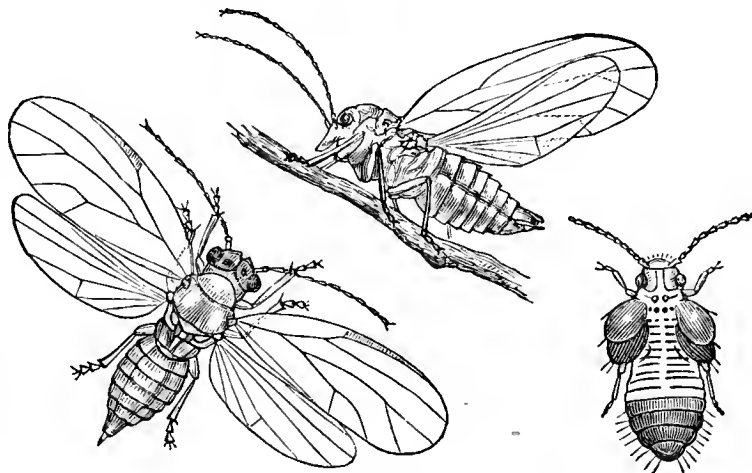
Those who desire to study the history and description of the insect in detail will find excellent information under the head of *Schizoneura lanigera*, in vol. iii. of 'Brit. Aphides,' by G. B. Buckton, F.R.S.; and there is also a long and serviceable paper on this insect by Dr. Cyrus Thomas, in his 3rd Annual Report as State Entomologist of Illinois, U.S.A. The method of formation of diseased growth is given by M. Prillieux, in 'Comptes Rendus' for April, 1875, and in short form from the above paper at p. 789 of the first vol. of the 'Gardeners' Chronicle' for the same year; also in the 2nd Edition of my own 'Manual of Injurious Insects' I give a paper on the American Blight, and means of prevention and remedy from my own observations, and other sources named.

Apple Chermes, or Apple-sucker. *Psylla mali*, Schmidberger.

The *Psylla mali*, the Apple Chermes or Apple-sucker, is a very small insect, usually of a bright green colour, about a twelfth of an inch in length of the body, and scarcely more than an eighth of an inch in length from the head to the tip of the transparent wings, when these are folded as they lie in repose.

The figure on next page shows the Apple-sucker with its wings spread, also raised as in act of taking flight, and likewise the general appearance in the pupal state, with the wings still undeveloped.

These Chermes or Apple-suckers have the power of doing great mischief by sucking away the juices of the young buds, and (later on in the spring) of the stalks of the blossom or blossom-buds. So far



PSYLLA MALI.

“Apple-suckers,” from life, with wings expanded, and raised in act of taking flight, mag.; nat. length one-twelfth of an inch. Pupa of Pear-sucker, mag., after Prof. W. Saunders.*

back as 1837 they were noticed in the Trans. of the Imp. and Royal Agricultural Soc. of Vienna as, though commonly causing no great injury, yet that in some years they were very numerous, and, when very numerous, that many blossoms were destroyed by them.

Although they are well known as British insects, I am not aware of there being any published record of observation of their habits, or of notable injury caused by this species in this country, and no mention is made of this infestation amongst the many valuable accounts of insect attacks given in the ‘Gardeners’ Chronicle,’ so far as I can find by search in the forty volumes I have at hand, being from the years 1841 to 1881 inclusive.

The first observations which I received of these Apple-suckers as a seriously injurious attack was sent me early in March by Mr. W. F. Gibbon, of Seaford Grange, Pershore, who followed up the life-history to the peculiar change of colouring, marking complete maturity of the sexes in the autumn, and subsequent egg-laying. And I was also favoured with able coincident observations, with specimens accompanying, by Mr. J. Hiam, of Astwood Bank, Redditch.

In all respects observed the history coincided with that recorded by various German observers, mainly by Schmidberger, who made an especial study of the habits of this insect; and of these I give the main points for comparison with the English observations of last season.

* The figure of the Pear-sucker is given merely to convey a general idea of the appearance of that of the Apple-sucker (which it much resembles) in undeveloped state, as I was unable to secure a specimen of the *P. mali* in pupal state for illustration. The figure is reduced from that at p. 146 of ‘Insects Injurious to Fruit,’ by Prof. W. Saunders Inspector-General of the Gov. Exp. Farm Stations, Canada.

It is stated by Schmidberger that in September, when the Apple leafage is beginning to turn yellow, the Chermes may be found in little parties of five or six on a leaf, especially on a yellowing leaf. The males are then stated to be of various tints, as of green striped on the back with yellow, or with dark yellow dots, or yellow with brown stripes; the females red along the entire back to the top of the tail, and striped with greenish yellow and brown, the abdomen orange-yellow or green.

After pairing the females leave the foliage, and lay their white spindle-shaped eggs singly, or several together, or sometimes in rows. These may be placed in various parts of the tree, in furrows, or year-old shoots, where there is fine hair. After this the Psyllas, or Apple-suckers, as they are called, die.

It is mentioned by Schmidberger that he never found an egg laid on a leaf. The first eggs were observed by him to hatch about the 5th of April, and the young Apple-suckers, just after hatching, had the body of a dirty yellow, with four dots across the back, the abdomen brown and the extremity dark brown, with whitish hairs. Such as were observed by Schmidberger to come out in the open air, at once betook themselves to the nearest bud, and began to gnaw the scales, and presently penetrated within to shelter themselves from cold and wet. [These points, which are of importance practically, were specially noticed in Mr. Gibbon's observations at Pershore last spring. —ED.]

After moulting for the first time, Schmidberger noticed that a white transparent tubercle issued from the extremity of the body, which remained attached by a whitish thread, and if removed, another tubercle or round globe and another thread was protruded. On the second moult "the larva not only puts out a thicker string with the tubercle, but also an immense number of very fine entangled threads or small hairs, which it turns upwards over its back, and with them entirely covers its body and head" (Schmidberger).

This strange mass of whitish threads I had an opportunity of seeing myself on specimens under observation about May 22nd.

Later on the rudiments of the wings make their appearance, and for the last change the Chermes fixes itself firmly, the skin splits, and the winged insect steps out from the cast-skin. The time that elapsed from hatching out of the egg to complete development was considered to be about four weeks. The date of appearance of the perfect insect in the open air is given as from the earlier part of May to the beginning of June.*

* See "Naturgeschichte der schädlichen Insecten, von Vincenz Kollar," in 'Verhandl. der k. k. Landwirthschaft-Gesellschaft in Wien,' 1837; also in English translation of above known as Kollar's 'Insects,' 1840.

The first observation of this insect was sent me on the 10th March, by Mr. W. F. Gibbon, of Seaford Grange, Pershore, in which he mentioned the insect as one which, although "almost unrecognised and certainly little mentioned," was the cause of great destruction to the Apple crop, and further observed:—"The presence of the *Psylla* on the Apple is always indicated by small, opaque, saccharine globules (vulgarly named 'honeydew') in and about the stalks of unopened flower-buds; and, if such a sprout be plucked apart, the young, flat, inert, wingless insect will be found in numbers sucking the juices of the stems of the blossoms. The flower buds, being deprived of their sap, shrivel up, and no Apples are produced, and the insect, casting its skin, appears in a short time in quite a different form,—light green, with transparent wings, active in habit, and leaping all about the tree."

Mr. Gibbon further noted, in comparing the effects of this and other Apple tree infestation, that the *Psylla* attacks the bloom buds, and completes its ravages before it can be noticed by the casual observer, sapping the stems of the blossoms before becoming expanded. Likewise that it harbours itself in the trees most crowded with growth; "consequently keeping the trees open is of importance, admitting, at the same time, the free access of birds to prey upon the insects."

On May 15th, Mr. Gibbon, after intermediate observations, forwarded me specimens in more advanced state; and a few days later I had the opportunity of myself seeing the protective covering of long and confused fine hair-like matter thus described by Schmidberger:—"The second changing of the skin can sometimes scarcely be seen at all, because the larva not only puts out a thicker string with the tubercle, but also an immense number of very fine entangled threads or small hairs, which it twines upwards over its back, and with them entirely covers its body and head." This covering was extremely noticeable, and in course of observations the ball and string mentioned at p. 6 was to be seen.

Later on, in reply to some inquiries as to these excrescences, Mr. Hiam wrote me that these excretions were perfectly well known to him, and, when looked at closely, had a purplish metallic shade on them. This agrees with Schmidberger's observation, that before complete development there is an appearance accompanying the ball and thread of numerous fine curly little hairs of a *light blue varying colour*, with which the abdomen becomes completely surrounded.

Corresponding in date of appearance with the above observations, Mr. J. Hiam, of Astwood Bank, near Redditch, sent me, on April 11th, information of damage to his Apple blossom from an insect which Mr. Gibbon, of Pershore, named as the *Psylla* then under observation; and of this Mr. Hiam remarked:—"I hardly know which is the worst

enemy, Chermes, caterpillar, or Aphis. I enclose some, as they are just hatching and crawling inside the buds in large quantities."

Later on—on July 4th—Mr. Hiam forwarded me some specimens of the fully-developed *Psylla*, remarking, regarding previous observation of the pest:—"Although I have recently seen a reference to the *Psylla* being a new pest, I have been well acquainted with the insect as long as I can remember on our Apple trees." And on July 7th Mr. Hiam further forwarded me a spray of Apple tree which has been injured by *Psylla*, showing how the bloom dies away without setting into fruit, and with this more specimens of the fully-developed Chermes or *Psylla*, thus enabling us to prove that the insects watched so carefully through their early stages from the commencement of the infestation were quite certainly the *Psylla mali* of Schmidberger.

To make quite sure beyond any doubt of this, I placed some of the specimens in the hands of Mr. Oliver E. Janson, F.E.S., of Perth Road, London, N., who favoured me with the following reply:—"Your determination of the *Psylla* as the *mali*, Schmid., appears to me to be quite correct. I have compared them with the specimens in the British Museum, which includes the types of the late Mr. John Scott's Monograph of *Psyllidæ* (Trans. Ent. Soc. Lond., 1876), and can find no difference. The bright green colour is similar to those which Mr. Scott separated in his monograph as a doubtfully distinct species, and named *viridissima*, but afterwards united it as a synonym of *mali*."—O. E. J.*

These *Psyllas* or Apple-suckers, I found, could run very well, and then, with a sudden skip, fly away. Their length somewhat under the eighth of an inch. The general colour apple-green, with the markings, as far as observable, of a pale yellow or yellowish green. These were somewhat variable, but might be described as one central patch on the fore part of the thorax (or body between the wings), two patches or marks on the succeeding part, and narrow cross stripes on the abdomen. Eyes in some cases pale, with the chief part reddish; in others white, with a central black spot, looking, as described by Schmidberger, like a black pupil.

The colours appeared to vary after death, as I noticed one specimen with a greyish band on the upper surface of the base of the abdomen. The antennæ were yellowish, dark towards the extremity,

* In the 'Catalogue of British Hemiptera,' by Edward Saunders, F.L.S., and James Edwards, F.E.S., 1890, the following synonyms are given for *P. mali*, Schmid.:—*ulmi*, Först.; *crategicola*, Först.; *viridissima*, Scott; *occulta*, Först. Dr. Franz Low, in his notes, 'Zur Systematik den Psylloden, Wien,' also mentions as synonyms *æruginea*, Först.; *rubida*, M. D.; and *claripennis*, M. D. This great amount of synonyms, which still does not include all that have been given to this one species, points to its variation in appearance, and variety of plants which it infests, and is further desirable to note for scientific reference.—Ed.

which was furnished with two setæ or small bristles; wings yellowish; legs pale, tarsi pale brownish, or tips of joints and tip of tibia dark.

On the 11th of September, Mr. Gibbon kindly sent from Pershore some specimens of the mature insect, then undergoing the change of colouring which accompanies pairing (quaintly described by Schmidberger as the wedding dress), with the remark, "The matured insect you will find in various forms and colours—some red from head to tail, some only red about the head and shoulders, some quite green, and some milky white."—(W. F. G.)

These winged Psyllas, or Apple-suckers, I found, as described by Mr. Gibbon, to be very various in colour; as green with yellowish patches on the thorax, and paler transverse lines or rings of pale colour on the abdomen; green, with the markings on the thorax of a redder tint, and a little red patching above the abdomen in addition to the pale lines; and pale yellowish, with a tint varying from red to brown along the top of the insect from the head to the tip of the tail inclusive.

At the same date, namely, Sept. 11th, Mr. Gibbon observed, "I have been watching daily to note the date of the laying of eggs, but I have seen none as yet"; but on Sept. 18th I was favoured by him with a little packet of twigs with "freshly laid eggs of the *Psylla mali*."

The eggs were scattered singly or a very few together, in furrows or protective hollows near the ends of shoots, and were whitish and spindle-shaped for the most part, some more obtuse and yellower. This was observed with a common hand magnifier. In a length of about an inch of shoot I counted (approximately) fourteen or more eggs. And on the 24th of September (thus completing the parallel observations at Redditch and Pershore) specimens of *Psylla* in the reddened tint of maturity, and on a *yellowing* Apple leaf, were sent me by Mr. Hiam.

In the course of the season Mr. C. Lee Campbell, of Glewstone Court, near Ross, also informed me that the attack had occurred badly to his trees.

From comparison of the observations given it will be seen how well these agree with the records of the Continental observers. The Apple-suckers in both cases are found, in the bright colours of maturity, in the earlier part of September; and this is followed by the white spindle-shaped eggs being laid in furrows or protective depressions of the surface, near the end of the shoots. In spring the newly hatched insects were to be found attacking the buds, and likewise seriously injuring the stems of the blossom buds; and our attack was watched onwards through the stages in which the insect is often to be seen, with a white ball appended by a thread to it, and also beneath a

covering of light hair-like excreted matter, up to perfect development.

But here we come on a very curious point, to which attention was drawn by Dr. E. L. Taschenberg. *Is there a summer brood?* Although in the case of Schmidberger's observation the Apple-suckers were developed in the first fortnight in May, nothing was noticed of egg-laying until September. In our case the perfect insects were not observable until early in July, which brings the dates of the first appearance and the reproduction nearer; but while on one hand it is curious and unusual that pairing and egg-laying should be so long delayed, on the other, even under the close attention paid by the observers, we have no record of appearance of the Apple-suckers in the young state, nor of observation of the change of colour so eminently noticeable at the September date of pairing preceding egg-laying. Various specimens of young insects were sent me for inspection; but where I was able to examine all details, these differed in material points from the young of *Psyllas*, and minutely resembled that of the pupæ of a species of *Eupteryx* or "Frog Fly," of which a figure is given in both 1st and 2nd Editions of my *Manual of Injurious Insects*.

PREVENTION AND REMEDIES.—Many of the eggs which have been laid near the ends of the twigs may be removed in winter pruning, and it would be desirable to destroy the prunings, or at least to take them well away from the neighbourhood of the trees, lest by any possibility the young Apple-suckers should creep up the trunks.

As they feed by driving their suckers into the soft tissues it is not likely that poisonous washes will have much effect upon them, and caustic applications if used at a strength to kill the insects, would probably also kill the tender tissues, such as the buds or young stalks from which they were drawing their food.

Where the young Apple-suckers are numerous enough to be causing real mischief *and are accessible*, probably the best remedy would be soft-soap wash with some addition of sulphur, or of quassia, or tobacco; but there is sometimes a difficulty in getting at them.

Mr. Hiam mentioned, "I have used insecticides with little effect, on account of their habit of secluding between the stems of the Apple bloom in the cluster or truss. I am using an old umbrella daubed or painted with the tree dressing inside with considerable effect, as the insects fly out and are caught when the tree is shaken or disturbed."

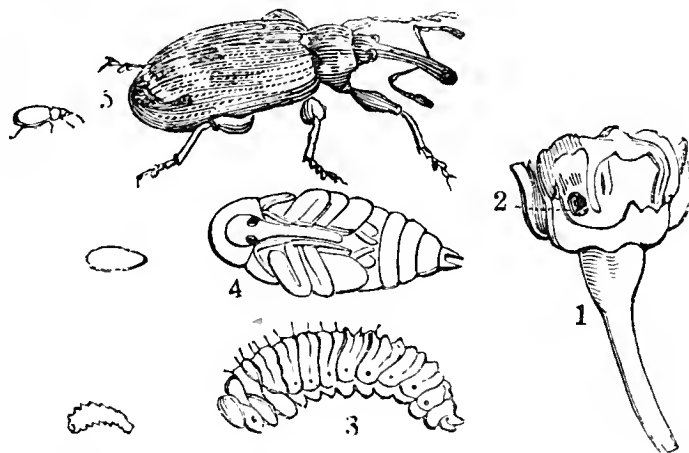
The above plan appears very practicable and might be acted on in an enlarged form, by putting tarred cloth beneath the trees, and shaking down on a broad scale.*

The observation of Mr. Gibbon, that the attack was most present

* For recipes for soft-soap washes, see Index.

where the boughs of the trees were crowded, is well worth notice. Though this attack has not been brought forward before as causing mischief in this country, there is good reason to think that it has been present, and it would be well in the spring, towards the end of April, to watch for its appearance in its early stages, in order to counteract its effects and check its increase.

Apple-blossom Weevil. *Anthonomus pomorum*, Curtis.



1 and 2, Apple-bud pierced by weevil; 3, maggot; 4, pupa; 5, weevil; all magnified with figures showing nat. size.

The Apple-blossom Weevil figured above, is a small long-snouted beetle, of a reddish brown colour, with various paler stripes and spots, and a pitchy-coloured patch on the wing-cases, with a pale stripe on it. The female beetle does much harm in some seasons, by boring a hole into the unopened flower buds of the Apple (and in a lesser degree of the Pear) with her proboscis, and laying one egg successively in unopened flower buds until her supply is exhausted. The maggots from these eggs feed each within its own flower bud, which therefore, instead of expanding, turns brown and dies, and the maggot presently changes, within the destroyed bud, to a chrysalis of the shape figured above and of some shade of ochry colour, and thence to the perfect beetle. These are said to remain throughout the summer on the fruit trees, where they feed on the leaves. "They are very shy and precipitate themselves to the ground as soon as they are approached."—(Schmidberger).

This is one of the regular old standing orchard attacks, which appear more or less every year. In some years it is very injurious, the amount of mischief in some degree depending on the season, because the beetle does not lay after the flower bud has begun to open, so that in a warm sunny season when the buds form and open quickly the female beetle, whose laying operations are very slow, has them cut short before completion by the buds having ceased to be in a state for laying in.

One important point brought forward by the observations of the past season as to the habits of this insect is how far the female beetle may be considered to reach the buds by flying rather than (as has been believed to be the case by some of our very best observers) by crawling or creeping along the boughs.

In the life-history of this insect given by John Curtis, he says, "In March when the flower buds are swelling, the beetles emerge from their retreats, when the males are seen in sunny mornings flying amongst the trees in search of the females, who generally are crawling over the branches, although they are also furnished with wings." And again, in the same paper, John Curtis says, "From various statements it seems that the females will not readily fly, and as they crawl up the trees their incursions may be stopped, and the crops saved, by winding tarred bandages round the upper portion of the trunks." *

It is also mentioned by Schmidberger (see Kollar's 'Insects') that, "The female beetle generally walks from one bud to another; nor are these insects often seen flying from branch to branch." Dr. Taschenberg mentions that they creep or fly.

Regarding this point, Mr. H. C. Staples wrote me the following observations from Swanley, Kent, on the 2nd of April, at which time he remarked that the blossom buds were becoming visible in some of the earliest trees.

"The Apple-blossom Weevil is now very active and plentiful; it is useless to dress the stems of the trees as this insect seems to fly as readily as any other. I have tried syringing the trees with arsenic in water, with soft-soap in water, and with paraffin in water, spreading paper beneath to see if any dead insects fall; only the last-named seems of any use, and that not in a very marked manner."

As the powers of flight of the female Apple-blossom Weevils, or at least their disposition to use them, are a very important consideration in arrangements as to prevention of attack, I suggested to Mr. Staples that it would be serviceable if he would make quite sure whether the specimens which he saw on the wing were females, by examining whether they contained eggs; and later on in the month (on the 25th) Mr. Staples reported, "I have killed several with wings which I have found to contain little creamy-white eggs, which, if magnified to the size of a Mustard seed, show a minute black spot on one side."

I did not see the eggs myself; but the description of the egg by Dr. Taschenberg is also as being white (without mention of appearance when magnified).

It would be very desirable if orchard growers during the coming spring would look further into this matter. It may be that as the weevils are very susceptible of weather influence, the females only fly when

* See 'Gardeners' Chron.' for 1844, p. 556.

the weather is very warm ; but thorough observation as to what is the prevailing habit, and whether it depends on state of weather, is needed relatively to whether sticky banding, on first appearance of the weevils, is worth the cost or not.

The following notes show the presence of the infestation in different parts of the country, with one estimate of proportion of blossoms injured, and some suggestions of very practicable method of destruction of the weevils before maturity, thus lessening amount of future attack.

On the 2nd of June, Mr. John Watkins (fruit-grower near Hereford) wrote me:—"I send a small box containing Apple blossoms, which are infested with a small white maggot or grub. I have been giving a good deal of attention to fruit-tree pests, but this is the first season I have noticed these. On pulling off the brown withered blossom you will mostly find one, in some stage or other, in the centre. Some of the trees have a large proportion of the blossoms affected." The box contained about fifty destroyed Apple-blossom buds, with the brown withered petals, instead of being expanded, forming a covering to the calyx and ruined centre of the flower, in which lay, in many cases, the *A. pomorum*, now in chrysalis state, and clearly showing the very long proboscis and dark eyes.

On June 4th, I had a note sent by Mr. Alex. Fairweather, from Wormshill, near Sittingbourne, Kent, mentioning that on examining the Apple bloom on the previous day he had found caterpillars quite enclosed in the dead blossom, lying at the bottom of the stamens, and in different stages of development (with lateral limbs like incipient wings). This attack also was obviously (from the details given) caused by the maggots of the Apple-blossom Weevil.

On the 6th of June, Mr. Staples sent me specimens of the Apple-blossom Weevil, with the remark that the small maggots so destructive to Apple blossom, "the prevention of which is now engaging so much public attention," were then turning to the little beetle of which he sent samples.

On the 16th of June, Mr. Hiam, of Astwood Bank, near Redditch, alluding to some Apple Weevil he had sent me a few days before, observed:—"These have been very destructive in the grub stage, eating all the inside out of Apple and Pear blooms, and causing them to fall off. I do not think I should exaggerate if I said they destroyed 25 per cent. of my blooms."

As a means of lessening amount of future attack, I suggested shaking down the blighted buds which contained the weevil in its grub or chrysalis state and destroying them. Mr. Hiam replied, "I have tried the plan you mention, and find it answers very well for what few affected bloom buds there are left on the trees, but have no doubt it would have been much more successful in catching the bulk of the

weevils if it had been attended to a fortnight ago in the case of Apple bloom, and a month ago for Pears."

The above observations of date of the weevil attack, show the beetles to have been very active and plentiful by the 2nd of April, when the earlier Apple-blossom buds were beginning to show, and eggs to be found in the females later on in the month. Then there was a lull in the observations after the weevils doing the mischief had ceased to be noticeable, until the results of their work became observable at the beginning of June in the numbers of brown, and destroyed, blossom buds, with the beetles in chrysalis state within, from which I had specimens of the beetle sent on the 6th and as late as about the 12th of June.

PREVENTION AND REMEDIES.—One good method of prevention which has long been known is to clear away from beneath the trees clods and stones, and bits of wood, or rubbish of any kind which might shelter the beetle during the winter. Also to keep the bark in such a condition that there shall be no shelter for the beetles in crannies or under broken pieces. But the plan of getting rid of the pest "whole-sale," as may be done by shaking it down in embryo, in the destroyed buds, does not seem to have been much brought forward.

Schmidberger noticed that where there were only dwarf trees in a garden, picking off the infested buds before they turned brown, that is, before the chrysalis was formed, answered perfectly and completely in preventing infestation for years; but he did not allude to possibility of *shaking* down the destroyed buds, which would make the clearance applicable to larger trees.

So far as last year's experiments showed, the plan would answer by taking the time early in June, when the effects of the attack were so far advanced that many of the infested buds might be shaken down, but still the chrysalids within would not have completed their change to beetle state. This plan would be well worth following up as far as possible next year, and reporting on as to how far the buds out of reach can be made to fall by jarring. Of course they should be shaken down on cloths, and all that falls burnt, or the chrysalids would mature in the buds as well below as on the trees.

The ordinary remedies of sticky banding, in case the beetles are found to be creeping up the trees, or of jarring to throw them down, are well known. In the latter case cloths smeared with something sticky should be spread below to prevent them getting away; or a hand apparatus, made simply of a piece of stout muslin or light cloth about two yards square, kept firm by a wooden rod or lath at each end, and one running lengthways and fastened to the centre of each end bar by way of a handle, would be useful. The handle or centre bar is only

used to connect the bar at each end, not fastened to the muslin, which is rather longer, and therefore hangs a little loosely below, so that the beetles can be shaken together and poured out into a pail to be destroyed; or the cloth may be stretched tight, and tarred, so as to catch the vermin as they fall. This kind of hand apparatus is found useful in American orchard insect prevention.

Anything deterrent, such as common whitewash with a little paraffin in it, or soft-soap with a little paraffin or sulphur added, and well applied to stems and branches, would be likely to be of some service in keeping off attack; but probably the best method of all for lessening amount of beetles would be destroying them in young state in the destroyed buds.

Winter Moth.—Observations regarding the Winter Moth (*Cheimatobia brumata*), the caterpillars of which are amongst the worst infestations which we have to Apple as well as to Plum foliage in the spring and early summer, are placed under the latter heading, because it was mainly on Plum trees that the trials of the effects of applications of Paris-green sprayings (which proved so satisfactory in their results) were made by the members of the Evesham Experimental Fruit Conference in the past year.

The position and date of egg-laying, also description of appearance of eggs, and other matters of serviceable interest regarding history and means of prevention of Winter Moth, will be found under the same heading.

BEANS.

Stem Eelworm. *Tylenchus devastatrix*, Kuhn.



Field Bean plant infested by *Tylenchus devastatrix*; nat. length, including curve of stem, about 10 in.

The opposite figure is from a sketch taken by myself of the whole of a plant of Field Beans, stunted and deformed by presence of the *Tylenchus devastatrix*, the Stem Eelworm (well known as the cause of "Tulip-root" in Oats, and "Stem-sickness" in Clover), so that the whole plant was only about ten inches high by five inches wide.

Up to this observation of 1890 of the deformed growth of the Bean plants in the field from which the specimens sent me were taken, there has been (as far as I am aware) no record of this attack being found to affect the Field Bean, that is to say, no record of the Stem Eelworm, the *T. devastatrix*, being found, on skilled examination, to be present in the stunted and deformed Bean plants.

In 1886, information was sent me by Mr. Drennan, of Goatfoot Farm, Galston, Ayrshire, that for several years he had sowed Beans as part of the green crop, and had found Tulip-root to be much worse on the plot where the Beans were, so he gave up sowing them, and, although the land had gone through a course of cropping, the Beaned plots were still worse than the other portions of the field.

Mr. Drennan forwarded me some stumps of Bean plants from land where Tulip-root had been bad in the previous year, and these I examined carefully for presence of Tulip-root Eelworms, but could find none. This, however, was easily accounted for, as the plants had been manured with a mixture containing sulphate of potash, which we have since found to be an excellent preventive or remedy of the Stem Eelworm.

In the same year—in the report of the condition of the Oat crops at the Highland and Agricultural Society's Experimental Station at Pumpherston—it was noted that the crop that season was Oats after Beans, and, in common with many fields under Oats, had suffered considerably, and Tulip-root was somewhat prevalent. Here, however, excessive drought was considered to be doing mischief.

In 1887, Mr. Drennan again forwarded me Beans and Oat plants from a locality which had suffered seriously from Tulip-root "for a number of years," and on examination, at my request, Dr. Ritzema Bos found the *Tylenchus* in the Oats, but *none* in the Beans.

No further notes were sent me on this special point until the 8th of August of the past season (1890), when Mr. J. R. Eve, Estate Agent, &c., of Luton and Hitchin, wrote me that on the previous day he had seen a case which he wished to report for consideration. He mentioned:—"I was valuing crops in this county, and on reaching a piece of Beans noticed a very marked difference, and that a portion of the crop had been more than half destroyed. The bailiff told me the Beans had been failing since before the time they came into flower, and that the destruction had been going on ever since. But the remarkable part is this, shown in the sketch accompanying this letter,

viz., that where the Beans are affected they followed *Oats* last year, and that the evil ceases immediately where Barley was grown last

Barley in 1889. (All Rye-grass in 1890.)	Oats 1889. Beans affected, 1890.
	Barley, 1889. Beans good, 1890.

harvest. There is still another mystery; the four rows (shown by dotted lines) by the side of the injured Beans are quite perfect, and Barley grew in 1889 by the side of these. I suggested to the bailiff whether the Beans were planted exactly at the boundary of the Oats, or whether they encroached somewhat on the Barley stubble; but he speaks with great confidence that this was not the case."

On examining the Bean stems I found Eelworms present in the rough or powdery matter within. These were few in number, and at first appeared, excepting in one doubtful instance, to be dead, or at least wholly motionless. After soaking in water, however, one became active, and I could clearly distinguish a spear with a bulbous base, and, so far as I could ascertain, it was the species *Tylenchus devastatrix*.

As it was very important to be quite certain as to the nature of the Eelworms, both with regard to damage to the Bean crops, and also with regard to rotation of crops on infested land, I forwarded specimens to the skilled examination of Dr. J. Ritzema Bos, of Wageningen, Holland, who wrote me as follows:—

"I examined the Bean stems, and, exactly as you wrote to me, I found in the inner blackish mass a great number of Eelworms. They were all in a lethargic condition. By damping them in water most of them recovered. The earliest were a pair of Eelworms without a spear. The next—or, at least, almost the next—to revive slowly had all a spear, and all the characteristics of *Tylenchus devastatrix*."

Dr. Ritzema Bos further added that all the reviving Eelworms were larvæ, and all possessed a spear, but that in this genus of Nematodes we cannot quite completely determine the species whilst they are still in larval state. He further added that amongst the crumpled-together Nematodes which had not revived he found one female which possessed a spear, which, it was tolerably apparent, was *T. devastatrix*, for the absolute and relative measurements agreed with those of females of this species; but up to this date no males were noticeable, which are needed for right determination of the species. Therefore I sent a further supply of diseased Bean plants, in which, as will be seen by the report of Dr. Ritzema Bos, given after my own description and measurements of these diseased plants immediately following, the male was present, and thus (through the skilled examination we were favoured with) we have certain knowledge of the presence of the

T. devastatrix in its various conditions of male, female, and larvæ in the stunted and deformed Bean plants.

These specimens, which were all mature, were sent me by request of Mr. Eve, from the Tingrith Manor Farm, near Woburn, Bedfordshire, shortly after the 12th of August. On carefully examining the six plants sent me, I found one plant to be not as much as four inches high, the stem flattened and widened, and swelled at the base, where it was evidently broken off at ground-level.

Two others of the plants were only about ten inches high. Of these one was fairly healthy in form, the other had eight side shoots from six inches length of main stem; these so placed that the whole plant, with its shoots and pods, had a kind of oval fan-shape, as shown in the figure at the head of this paper. Some of the pods were straight and rightly shaped, but a large proportion of them were stunted and distorted, and some of them were scarcely as much as three-quarters of an inch in length. The lower part of the thickened stem was much curved, and in the case of another of the plants the stem was so much curved just at ground-level that (although it was altogether scarcely more than twelve inches high) about three inches of the length was nearly horizontal. Another of the plants sent me was also slightly swelled and deformed, and very much shortened in growth.

The sixth plant was fairly healthy, and served as a kind of scale to give some idea of the amount of harm that had happened to the injured specimens; in this case the stem was over three feet and a half in length.

On forwarding some of the Bean plants to Dr. Ritzema Bos, he made examination and found the male, which possesses a bursa. Therefore, as Dr. R. Bos wrote, "the Eelworm which infests the Beans is a *Tylenchus*"; and further, "the dimensions of the various parts of the body, the relation between the length and the breadth, and the absolute length of the Eelworms, are such that I have no doubt at all that the Eelworm which infests the Beans is (just as you supposed) *Tylenchus devastatrix*."—J. R. B.

This Stem Eelworm (the *Tylenchus devastatrix* scientifically) is a minute transparent-white threadworm, at its full growth scarcely more than 1-25th of an inch in length, and its greatest breadth may be said in a general way to be 1-30th of its length. The full microscopic details are given under "Tulip-root," together with a full-page plate of the male and female Eelworm, after drawings by Dr. Ritzema Bos, Professor at the Royal Agricultural College, Wageningen, Holland; but the above general statement of measurement is also desirable to notice, because an entirely different kind of small white worm, often to be found near the roots of plants, which, though very minute, are yet

quite large enough to be seen by the unassisted eye, are often mistaken for the Stem Eelworms.

Other kinds of true Eelworms, probably all harmless, may be present, but with good microscopic powers the *T. devastatrix* will be seen to have in the gullet (œsophagus) a sharp point known as the "spear" set on a bulbous base, which in the *Tylenchi* is 3-lobed; this is some assistance in identification, though the species cannot be thoroughly identified without examination of the male Eelworm for the presence of a *bursa* or purse near the caudal extremity. Very few but specialists can identify these minute threadworms trustworthily, but in Tulip-root, and in the peculiar growths of Clover in "Stem-sickness," and now in the peculiar deformed growth of Field Beans caused by this infestation, we have the plain outward signs of what is the cause of mischief within so clearly noticeable that for serviceable practical purposes constant microscopic investigation is quite unnecessary. These Eelworms propagate by laying eggs, and may be found in the infested plants in all conditions, that is, as larvæ, and also as males and females.

PREVENTION AND REMEDIES.—As we have only known certainly towards the end of the past season of the existence of this infestation in Field Bean plants, it is impossible to say yet what treatment will succeed; but it may fairly be supposed that just the same applications will do good which have proved thoroughly serviceable in checking the same kind of attack in Clover and Oats.

For Clover a mixture of sulphate of potash 3 cwt. and sulphate of ammonia 1 cwt. per acre was found, at Rothamstead, to act thoroughly well. Sulphate of iron, at the rate of 2 cwt. the acre, also answered very well; but at the rate of 1 cwt. was not so successful.

A mixture of sulphate of ammonia 4 parts, sulphate of potash 1 part, and steamed bones 2 parts, given at the rate of $1\frac{1}{2}$ cwt. per acre, followed up by a dressing of 2 cwt. per acre of sulphate of ammonia, has been found to act well as a dressing for Tulip-rooted Oats or Stem-sick Clover.

A mixture of sulphate of potash 2 parts, sulphate of ammonia 3 parts, together with 4 parts of phosphates, has given very good results, and a mere top-dressing of sulphate of potash at the rate of about 1 cwt. per acre has been reported as checking the Eelworm (Tulip-root) attack in Oats, so that an excellent crop was cut.

Methods of prevention have been fully entered on in detail before,* so that it is only necessary just to allude to them. Many of the

* See 'Reports on Injurious Insects' for 1886—1889, and 2nd Edition of 'Manual of Injurious Insects,' also by E. A. Ormerod, Messrs. Simpkin, Marshall, Hamilton, Kent & Co., Stationers' Hall Court, London, E.C.

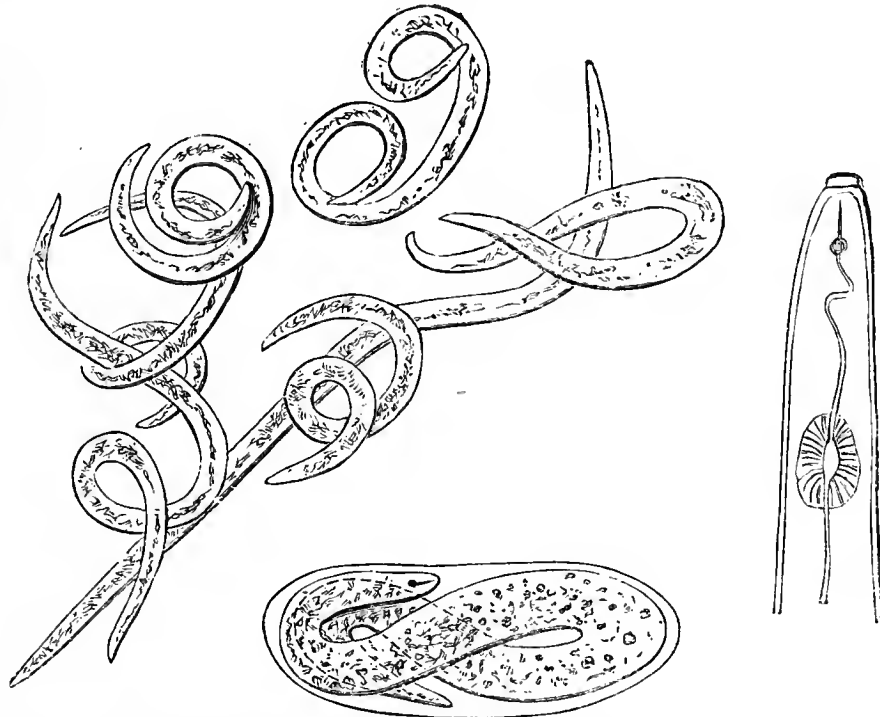
Eelworms leave the plants, and remain in the upper part of the land ; therefore preventive measures consist first and most importantly in a rotation that does not give one kind of crop notably liable to Eelworm attack to immediately follow a crop obviously infested. Thus Oats should not follow Stem-sick Clover, nor Clover, Tulip-rooted Oats ; and now we find that Field Beans require attention as to their powers (as a general thing) of taking the infestation. Potatoes also are liable to attack of *Tylenchus devastatrix*, but it has not been as yet reported as present here.

The Eelworms are *not* necessarily destroyed by processes of digestion, so that the very same Eelworms which were taken off the field in infested straw, &c., for fodder, may be returned to it in manure.

Very deep ploughing, or ploughing with a skim-coulter, or (where only small patches of a few yards have to be dealt with) trenching so as to turn down the top spit, are good mechanical measures of treatment.

CLOVER.

Stem Eelworm. *Tylenchus devastatrix*, Kuhn.*



Stem Eelworm (*Tylenchus devastatrix*) ; anterior portion of female showing mouth-spear ; and embryo in egg ; all greatly magnified (anterior portion mag. 440 times). From figures by Dr. J. Ritzema Bos.

Only a few observations on Clover Stem-sickness, caused by the attack of the Stem Eelworm, have been sent in the past season. From

* The above wood engraving is merely given to save reference as to general appearance. For highly magnified figures of male and female *Tylenchus devastatrix*, together with figure of eggs and other details, the reader is referred, as before mentioned, to plate accompanying paper on "Tulip-root."

these I give the following description of infested plants sent to me in July by Mr. J. R. Eve, of St. Paul's Square, Bedford, as I found the diseased growth to be most markedly present.

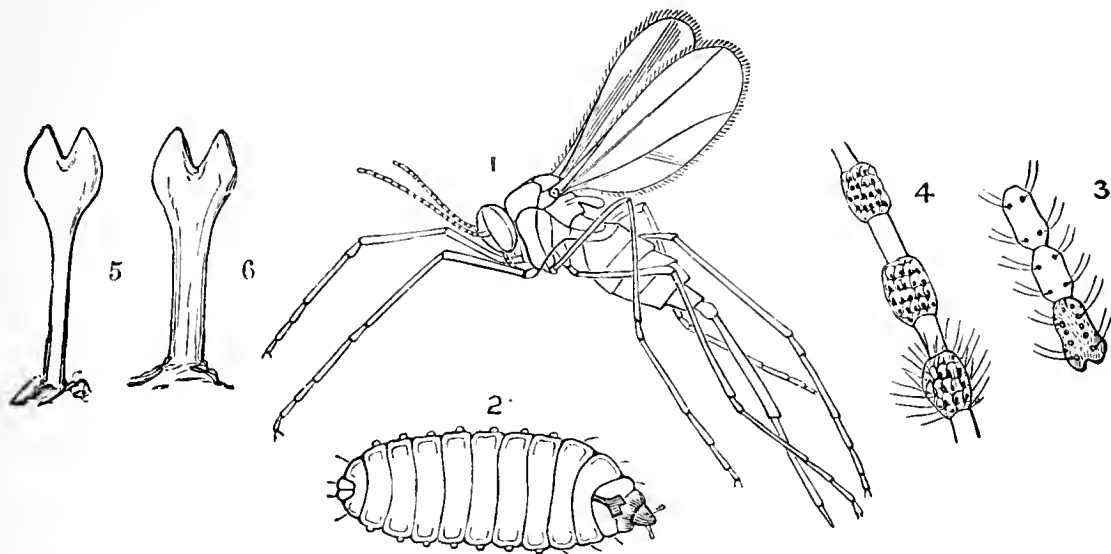
On the 8th of July, Mr. Eve wrote me to inquire the cause of the Clover plants in the fields dying off, "blind specimens" of which he sent at the same time. He also noted that "for the last three months the Clover had been getting less and less." The term of "blind specimens" very well described the condition of the plants. The flowering stems were shortened, and down at the root, or rather above ground-level, were the thickened buds so characteristic of *T. devastatrix* attack. In one case there was quite an aggregation of these at the summit of the tap root; two shoots only had pressed on in a fairly normal state. About three others were stunted to about an inch in length, forming masses of thick, short, elongated buds, or swelled shoots. One of these had thrown out one shoot about an inch and a half long, with a characteristic swelled leaf bud near the end. There were also so many other distorted small buds on this plant as to make a thick mass at the top of the main root, and on one of the moderately healthy but shortened stems there was also a small hard bud at the axil of the leaf.

The attack was so bad that Mr. Eve mentioned there was no intention of attempting to save the crop, as there was not one acre out of twelve where Clover could be seen.

Amongst the other observations the only one referring to large presence of this infestation in a district was sent me from Alford, Lincolnshire, on the 6th of July, by Mr. Eardly Mason, who reported that many complaints of the Red Clover going away had been made to him, and the special attack which he had been able to examine "was certainly due to this plague." Information was also sent me of good success of treatment previously advised.

A short description of the Stem Eelworm, the *Tylenchus devastatrix*, and methods of treatment found thoroughly serviceable in checking its attacks, will be found at pp. 19, 20 in the preceding paper. The infestation to Clover has been so fully entered on in my 13th Report, under the head of "Clover Stem-sickness," with notes of prevention, that it is unnecessary to repeat the observations here; but the reader will please notice that the observations only refer to the special disease, "Stem-sickness" caused by the "Stem Eelworm," and recognisable by the deformed growths of the Clover plants. Disease caused by unfavourable weather, unsuitable soil, or fungus attack, commonly known as "mould," fall under different considerations.

American Clover-seed Midge. *Cecidomyia leguminicola*, Lintner.



CECIDOMYIA LEGUMINICOLA.

1, Clover-seed Midge; 2, maggot; 3, portion of female antenna, with minute hairs figured on lowest joint; 4, portion of male antenna; after Professor Riley; 5, anchor process; all magnified; after Dr. Lintner; 6, anchor process, figured from English specimens, also magnified, by Ed. Nat. length given in descriptions.

So far as we are aware, the American Clover-seed Midge has only appeared lately in this country, but still we cannot tell with certainty how long it may have been here.*

From the well-marked differences in form which I have found on examination of the anchor processes of "red maggots" found hibernating in the earth at Clover roots during the winter, I am aware that two kinds of Cecids are present, and very likely the maggots of both kinds may feed on the seed. Of these two kinds, however, I have only as yet been able to note the American Clover-seed Midge, the *Cecidomyia leguminicola*, Lintner, in its various conditions, that is, as present as a red maggot in the infested seed heads in summer, and in the ground in the winter, and also as the perfect Gnat Midge.

The species is of comparatively recent observation even in America. An insect much resembling it in appearance, and very likely of this species, was observed about 1850; but it was not until the year 1879, after careful watching for a year or two, that the Gnat Midge was reared by Dr. J. A. Lintner, now State Entomologist of New York

* Careful observation is requisite in identifying this attack. Besides the possibility of another kind of *Cecidomyia* attack being present in the heads, there are also small brilliantly red-coloured fly maggots, very much resembling the *Cecidomyia* maggots in shape, but distinguishable by having a very few longish hairs, especially at the tail; also by the absence of an anchor process, and by the presence of two lobes or wide processes at the tip of the tail, each of which are sharply bifid. Besides these is the long and well-known attack of the maggots of the Clover Pear-shaped Weevils to Clover seed in the heads. These are much the same size, and do mischief much in the same way as the *Cecidomyia* maggots, but may be distinguished by being white, fleshy, and furnished with a brown head, armed with jaws. For figure see p. 27.

State, and determined by him as a new species. Observations of the life-history were published successively by Dr. Lintner and Professor Riley, and in 1881 an excellent and exhaustive paper on this same insect was published by Prof. W. Saunders, in the 12th Annual Report of the Entomological Society of Ontario. This paper embodies all information up to date on habits and life-history of the insect, together with serviceable suggestions as to prevention and remedy. In this country also we have come, so far as I am aware, very gradually to a certain knowledge of the *C. leguminicola* being here.

Notes were sent me which pointed to its possible presence here a few years ago, and later on, in the winter of 1888-89, I found specimens of maggots agreeing with descriptions of the Clover-seed Midge maggot amongst specimens which were hybernating at the roots of Clover, and about the third week in April I reared from these larvæ a specimen of the true Clover-seed Midge, the *C. leguminicola*, Lintner. It was not, however, until the middle of September, 1890, that I had an opportunity of seeing the maggots in their summer condition, destroying the seed in the heads of Red Clover exactly as described in the American reports.

On Sept. 16th, Mr. Alfred Hutley, of Derwards Hall, Bocking, Braintree, Essex, wrote me that he enclosed a few of the heads of Red Clover, which he had purposed saving for seed, but finding, on examining a section of the heads, that a maggot had destroyed a large proportion of the seed, he had cut it that day for hay, and wished to know if there was any remedy or prevention of the attack.

These maggots were almost indistinguishable, by the naked eye, from the well-known "red maggot" of Wheat. They were footless, of various sizes, from about the sixteenth to the twelfth of an inch in length, and of various shades of orange or somewhat pinkish orange. The "anchor process" (that is, a horny process beneath the body near the head, which varies much in form in different species of *Cecidomyia*) was deeply cleft or notched at the extremity, as figured at p. 23.

On tearing open some of the Clover heads I found that, besides the "red maggots," which had left them during transmission, there were still some remaining amongst the calyces of the florets, and also a great many of the husks were either without seed, or with the seed in injured condition. One head amongst the specimens sent, in which the seed was rightly developed, contrasted very strongly in regularity of form and size of husks containing the seed, and also in uniformity of colour, with those where, apparently solely from this infestation, the seed within had been ruined.

The maggots agreed in all noticeable respects with the American descriptions, and also in the habit of leaving the flower heads to go through their changes in the ground, or on the surface of it, below the infested plant. The regular method of life where noticed in America,

is for the maggots of the first brood to leave the Clover heads in July. The gnat midges from these come out in August, and the maggots from eggs laid by these will be in the Clover heads of the late crop in September.

The maggots of the late brood may, according to weather and special circumstance, remain undeveloped to the perfect insect until the following spring, or the gnat fly may appear during the autumn or winter.

To the unassisted eye, this appears merely like a little blackish or brownish two-winged gnat, about the eighth of an inch in length, and so much resembles the Clover-leaf Midge which is a European kind, that the two species can only be distinguished trustworthily by microscopic examination.

Of this (the *Cecidomyia trifolii*, Loew.) Dr. Lintner says the principal differences given are its smaller size, and two antennal joints less in the female (fourteen instead of sixteen).

In order to be perfectly certain of the identity of the species which I reared, I submitted a specimen to Mr. R. H. Meade, of Bradford, who kindly examined it and informed me "that it is without doubt Lintner's *Cecidomyia leguminicola*." The specimen was a female, and corresponded, in the important point of characteristics of the antennæ, with the figure and description.

The following is the description of the Clover-seed Midge given by Prof. Saunders:—"The perfect insect is a minute two-winged fly, about the size and general appearance of the common Wheat Midge. The head is black; the antennæ long, yellowish red, with sixteen or seventeen joints in the female, and fifteen in the male. Wings nearly transparent, clothed with many short curved blackish hairs, which give them a blackish appearance; each wing has three longitudinal veins, the third either forming a fork, or else becoming more or less obsolete towards the tip. Hairy fringe of wings paler and composed of longer hairs than those on surface of the wing. Abdomen fuscous with black hairs above on each segment; thorax black and clothed with rather long hairs. The male has an extended pair of clasping organs on the hinder extremity; the female a long pointed ovipositor, about twice the length of the abdomen."*

In the same paper Prof. Saunders notes "that the method of change is for the maggots after they have left the Clover heads and gone down into the ground, or into leaves or rubbish on the surface, to spin each for itself an oval compressed rather tough cocoon of fine silk, with particles of earth or other material adhering to the outside." "The duration of the pupa state of the early brood is about ten days."—(W. S.)

* See paper on the Clover-seed Midge, *Cecidomyia leguminicola*, Lintner, by Prof. W. Saunders. 'Twelfth Annual Report of Ent. Soc. of Ontario,' p. 39.

PREVENTION AND REMEDIES.—From the nature of the attack nothing at all can be done to stop the ravages of the maggots, when once they are established in the heads. The only paying course then is to cut the crop for hay.

Something, however, towards prevention of sowing a future infestation together with the seed may be done by careful examination of the seed before sowing. Most of the maggots leave the seed heads, but not all. In specimens sent me at my request from stacked infested Clover, I found maggots of this kind present on the 20th of October. As the maggots may live on amongst the seed until next spring, as they would have done in the ground, attention to this point is strongly urged amongst American methods of prevention.

Prof. W. Saunders, Director-General of the Government Experimental Farm Stations of Canada, says:—"It is of the utmost importance that farmers exercise the greatest caution in the purchase of Clover seed, else, while sowing their seed, they may at the same time be sowing an enemy, that will to a greater or less extent destroy the crop. Seedsmen also should exercise great care, otherwise they may be the means of seriously injuring the Clover-growers in the district by the introduction and dissemination of this pest." *

Infested seed may be easily known by looking for the "red maggots," which will show as little orange or reddish bodies amongst the grains. Seed may very likely be foul, if from infested Clover heads, whether it is home-grown or imported from America. Obviously such seed should not be purchased, and if it is sown with the maggots or chrysalids alive in it, this amounts practically to putting in the seed of the infestation along with the seed of the next crop. Various methods of disinfecting the seed have been suggested, as putting it in a closed vessel and exposing it to fumes of bisulphide of carbon, or some kind that would destroy the grubs. But in this method care must be taken *both as to what is used and the amount*.

Dressing or steeping the Clover seed in the way often practised with Wheat would in all probability kill the red maggots; but experiment here also would be needed, both as to what kind of applications might be used with safety, and also what strength is safe. If the seed was left too long after being wetted before being sown, this also might ruin the germinating powers.

In the case of dressing Beans infested by the Bean-seed Beetle, it has been found that Calvert's carbolic acid has been of service, and also a dressing of 1lb. of "blue vitriol," and 1 pint of McDougall's sewage carbolic, with 6 quarts of water. This was used with success for 6 bushels of Beans.

How far the above would be safe for the small Clover seeds even

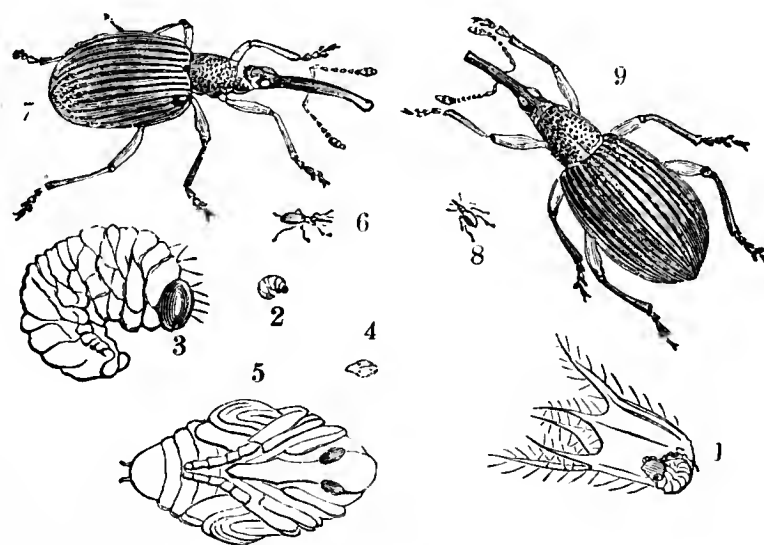
* See Report by Prof. Saunders previously quoted.

when far more diluted than in the above proportions, I do not know, but it might be expected that an exceedingly weak solution would kill the maggots, and it would be well worth while to experiment as to what would be, at the same time, a safe strength for the seed.

Where a district is infested, the only plan known of getting the infestation under is either to leave off Clover-growing for a while, or to cut the crop whilst the flowering heads are still in an early condition. Thus it may be taken whilst the maggots in the heads are still so young that they will die for want of the supply of food that the growing seed would have furnished before they reach maturity, and condition for full development.

Where infested Clover ley can be broken up towards spring, when the maggots are turning to the chrysalis state, this would destroy many of them. Early in the winter, or in the autumn, it would kill some that were buried down too deeply for the gnat midges to come up through the ground after development, but would probably only temporarily disturb many of them which were still quite able to re-bury themselves.

As it is very possible that the above infestation in Clover heads may be confused with that of the Clover Pear-shaped Weevils (*Apions*), of which the little whitish maggots are also very injurious to the forming seed, I add the figure of this weevil beetle in its different

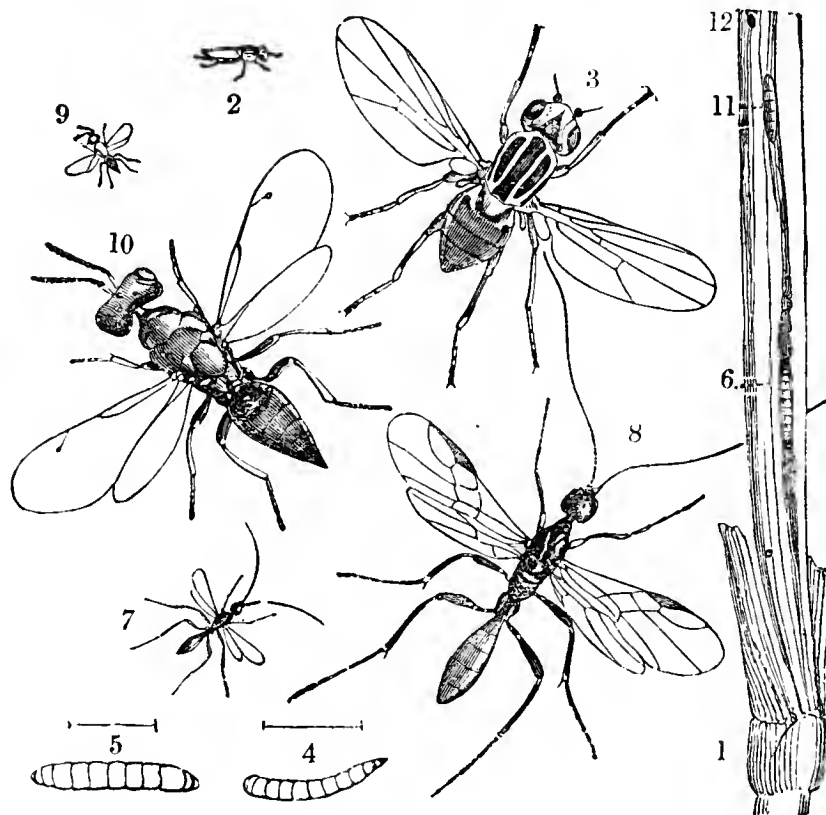


6, 7, *Apion apricans* ; 2—5, maggot and pupa ; 8, 9, *A. assimile* ; all nat. size and magnified ; 1, maggot feeding, magnified.

stages. It will thus be seen that the two kinds of minute seed-feeding maggots, although about the same size, may be easily distinguished by the beetle maggot having a distinct dark head, as well as by being commonly of a much paler tint than the various shades of orange-pink or red of the midge maggots.

CORN AND GRASS.

Gout Fly; Ribbon-footed Corn Fly. *Chlorops taniopus*, Meigen.



CHLOROPS TANIOPUS.

2—6, 11, maggot, chrysalis, and fly, nat. size and magnified; 7 and 8, *Calinius niger*; 9 and 10, *Pteromalus micans* (parasite flies), nat. size and magnified; 1 and 12, furrowed Corn stem.

The attack of the *Chlorops*, or Gout Fly, is one of the very commonest and most regularly recurring of those insects injurious to the growing Barley ear and stem that we have in this country; and all moderately observant agriculturists cannot fail to know the presence of the infestation well, by the swelled and deformed growth of the sheathing-leaves of the ear, which sometimes, as in the opposite figure, is unable to escape from them, and remains as a stunted plant for life.

More frequently, however, it wholly or partially escapes, and then the attack is recognisable by more or less of the lower part of the ear having been destroyed by the fly maggot, and a brown or blackish channel being observable from the ear down one side of the stem to the uppermost knot (see figure). Here the legless whitish maggot has fed its way onwards, and there it turns, within the sheathing-leaves, to a rusty-brown chrysalis, from which the little stumpy-made, two-winged, black-and-yellow flies come out very soon, and may be found sometimes, as I have found them myself, in such numbers in an infested stack just harvested, that when I have thrust one arm well down amongst the straw I could sweep the flies out in such numbers that they fell fairly rattling down on the sheet of paper I held below.

All this, that is, the *summer* history and habits, is perfectly well known; but (so far as I am aware) it was not until this past season that an observation of *winter* attack was secured in this country. In this case the kind of injury is necessarily different in form from what takes place in summer. The following description is taken from the very clear account quoted by Dr. E. L. Taschenberg from the paper by Prof. Max Nowicki* :—

An egg is laid on the leaf of the winter Corn, or of a wild Grass. The larva, which hatches very soon, bores into the inside of the young plant, even to the neck of the root, and there it passes the winter; but it is not till growth begins again, towards spring time, that the infested plants are distinguishable from the others. Then the infested shoots assume a somewhat bulb-like appearance, with broader leafage, and the whole growth thicker than the growth of the uninfested shoots.

In these shoots the *Chlorops* maggot is to be found, and in due course, whilst the over-luxuriant infested shoot perishes, the insect goes through its changes within, and emerges as the perfect fly, in time to start infestation in the summer Corn. (This may be Barley, Wheat, Rye, or wild Grasses.—ED.)

This form of attack has been watched for (or rather I have suggested it would be very desirable to watch for it) for several years back, and in the course of May last year specimens of infested young Wheat plants were placed in my hands for examination by Mr. C. Whitehead (Chairman of the Seeds and Plants

* Nowicki, Prof. D. Max, *uber die Weizen-verwüsterin Chlorops taniopus*, Mg., und die Mittel zu ihrer Bekämpfung. Wien, 1871.



Plant of Barley entirely stunted by Gout Fly attack.

Diseases Committee of the Royal Agricultural Society), which he had received from Dr. Fream, of the College of Agriculture, Downton.

The specimens from which these were taken, Mr. Whitehead informed me, were sent to him about the middle of April, and from them one of the perfect "Gout Flies" emerged on May 11th. This first specimen Mr. Whitehead placed in my hands, and as there were points about it which made me hesitate as to whether it could with absolute certainty be considered the common kind of Gout Fly known as *Chlorops taniopus*, and also it was found in Wheat (which with us is less commonly infested than Barley), I submitted the specimen to Mr. Meade, of Bradford, who was good enough to examine it, and replied as follows:—"I believe your *Chlorops* to be a female of *taniopus*; it is not *lineata*. I thought at first that it might be *C. nasuta*, which is a very variable species, but upon close examination I feel convinced that it is a variety of *C. taniopus*."

Of the other specimens sent me, one chrysalis case had fallen from the plant, so that I could examine it, and I did not observe any difference between this and the common form of Gout Fly chrysalids, and within it the fly was so far advanced that its shape was clearly distinguishable. Another chrysalis was low down in the centre of the little plant, of which I noticed that one at least of the leaves was much wider than in natural circumstances.

This observation is of interest as showing that the winter form of attack is to a certain extent present here; but until we know more about its prevalence, and especially whether it may commonly be found in Wheat, we can hardly utilise it practically.

It may be useful, however, to give a short description by which the maggots of three different kinds of flies, all of which do mischief very much in the same way in their method of winter attack within the shoots of young winter Corn (that is, independently of their summer method of attack), may be distinguished from one another.

These are the maggots or *larvæ* of the Gout Fly or Ribbon-footed Corn Fly (*Chlorops taniopus*), the Frit Fly (*Oscinis frit*), and the Wheat-bulb Fly (*Hylemyia coarctata*).

These maggots all resemble each other in being whitish or yellowish in colour, legless, cylindrical in general shape, but somewhat tapering towards the head end which contains the mouth hooks, and blunt at the tail extremity.

The maggots of the Gout and Wheat-bulb Fly may be generally described as about the fifth of an inch in length when full-grown; those of the Frit Fly are smaller.

The main differences between these kinds of maggots, as seen with a tolerably strong magnifier, are as follows:—

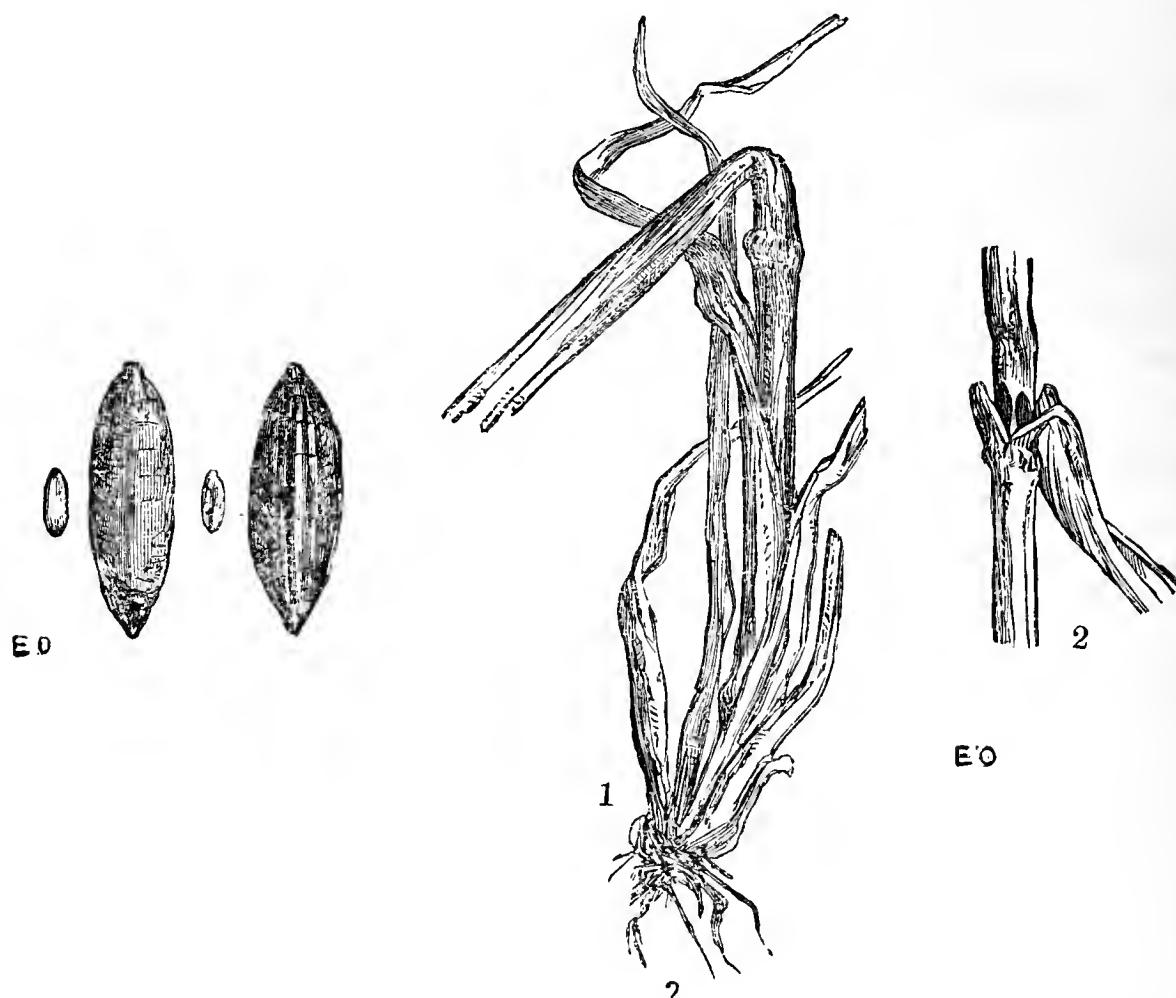
The maggot of the "Gout Fly" has two spiracles, projecting like

two white points, at the blunt or rounded hinder extremity, and the pair of mouth hooks at the somewhat tapering front extremity (what may be called the head end) are very small. The maggot of the "Frit Fly" has two projecting spiracles at the blunt hinder extremity, and is bluntly pointed at the head end, which contains two strong mouth hooks, and on each side near the head it has a branched spiracle. The maggot of the Wheat-bulb Fly has a pair of fleshy, somewhat flattened, square teeth at the extremity of the blunt hinder extremity, and on each side of this central pair is one tubercle or tooth and sometimes more. When examined under a magnifier the central teeth will be found to be concave at the extremity. The head end contains two powerful black mouth hooks. For figures of these details see paper on Wheat-bulb Fly.

On the 9th of July, in the past season, Mr. Eardley Mason wrote me from Alford, Lincolnshire, that on examination of fields in that neighbourhood he found *Chlorops* attack was abundant, but otherwise only a few observations of presence of the infestation were sent me. These, for the most part, were only enquiries as to the nature of the attack, with specimens accompanying; the dates of application being from July 29th to August 25th; the localities near Bridgwater, Leominster, Doncaster, and Nottingham. Amongst these, however, the following note is of interest, which was sent on the 29th of July, from Springhill, Bulwell, Nottingham, by Mr. Arthur Gibson. This, it will be seen, gives an estimate of loss, and also notes that the infestation only occurred where seed from a locality and kind of land named was used. Mr. Gibson wrote:—"I have taken them (the specimens of infested Barley, Ed.) from a 16-acre field of Barley. I notice the attack on one side of the field only; the crop generally is a heavy one, but at the spot from where I gathered these ears there would, I should say, be quite 10 per cent. similar to those I send you. I had the seed from Goole,—Wharfe land. My other fields appear quite clear from the pest where different seed was used."

No advance was mentioned in methods of prevention or remedy beyond what has been previously reported, and of these the most practicable measure appears to be that brought forward in 1889 by Prof. W. McCracken, as observed by himself at the Royal Agricultural College, Cirencester, of the beneficial effects of early sowing. In the instances he gave me (see my 13th Report) the portion of the crop sown in March was free from injury; that sown on April 6th was injured to the extent of 2 per cent., and that sown on May 3rd to the extent of not less than 20 per cent.

Hessian Fly. *Cecidomyia destructor*, Say.



1, Barley stem elbowed down by Hessian Fly attack; 2, showing position of "flax-seeds." Also "flax-seeds" or puparia nat. size and magnified, showing the early and smooth, and the later or striated, condition.

From the reports of the past season (joined to those of the previous years), since Hessian Fly was first recorded in 1886 to be present as a crop pest in this country, the infestation appears to be distributed at localities in most of the English counties excepting the most westerly and south-westerly, but at the same time so far as the reports sent to myself show, the injury caused is for the most part what is described by various of the English observers as "immaterial," "slight," or of "no consequence," a "trace" and so on.

The highest estimate of damage sent, and this only from one locality was in Barley, two stalks in well grown crop, and ten in shortish crop in square yard; in Wheat from two to five stalks.

From Scotland, whilst notes were sent of non-observation of the attack at various localities, I had only at the most two of its presence, and one of these mentioned the mischief locally as "very considerable," the only note sent of serious injury.

As this attack still continues to be of considerable interest, I give the following notes in the order of date, and in the words of the senders (so as to convey the precise information sent), and append remarks on some points on which information up to date is desirable, more

especially regarding parasites and altered forms of growth by which the winter attack of Hessian Fly maggot in young Corn may be recognised if present.

My first note of Hessian Fly presence in the past season was a short remark from Prof. Harker, of the Royal Agricultural College, Cirencester, on the 19th of July, "Hessian Fly very numerous."

On the 25th of July, Mr. Geo. E. Palmer, of Revells Hall, near Hertford, who it will be remembered was the first observer of this pest in England, wrote me in reply to my request for information as to amount of attack:—

"I have made a careful examination of our Wheat and Barley crops with the following result.

"*Barley*.—Damage from the Hessian Fly slight, a few stalks here and there being broken down and containing the puparia.

"*Wheat*.—No perceptible damage, although there is occasionally a stalk attacked or broken down. On the whole I should say Wheat and Barley in this neighbourhood are very little damaged by Hessian Fly. It is possible that there is more of the pest in the Barley than can be seen by observation now, as the heavy rains have laid the Corn badly, and it will not be till the straw is passed through the thrashing-machine that we shall be able to see what amount of the puparia there is in it.

"In my opinion it will only be in dry seasons that we shall experience much damage to our crops from this fly."

Mr. Palmer's view, as above stated, of but little damage being done by the Hessian Fly, was later on confirmed by the results of thrashing two stacks of Barley, of which he sent me a special note, on Oct. 24th, in reply to my enquiries:—

"Judging from the amount of puparia to be found in the screenings, I should say that there was not so much Hessian Fly this year as there has been previously, and this receives further confirmation from the fact that the yield of Barley is the largest we have had for a good many years. I have not been able to ascertain what amount of damage has been done on neighbouring farms, but I do not think in any case it has been at all serious, or I should no doubt have heard of it."

Returning now to the reports of amount of presence on the growing crop:—On the 25th of July, Mr. S. L. Mosley, writing from Beaumont Park Museum, Huddersfield, observed that he had looked for the Hessian Fly repeatedly in that part of Yorkshire, but had not succeeded in finding it.

At the same date, also, Mr. J. Eardley Mason, writing from Alford, on the east of Lincolnshire, observed, "I reply to your enquiry respecting Hessian Fly that I have found it, both as larvæ and puparia, in every field I have examined, but sparingly."

On the 30th of July, Mr. D. Taylor, of Daleally Farm, Errol, N.B., who has reported on the pest at intervals since his first observation of it in Scotland in 1886, wrote, in reply to my enquiries, that some spots were pretty sorely attacked; "but generally speaking, for I went out and made a thorough inspection of Wheat and Barley last night, the number of attacked stalks in a square yard I find to vary from two in thick well-grown Barley to, say, ten in a shortish thin crop. The Wheat being stronger is not so broken down, say from two to five in a square yard. But one fact here, and I would like if others would report their experience: I find that in the thin weakly crops growing under cover of trees, or say in a sheltered situation, as much as (well, putting it inside the mark) forty per cent. are broken down; in fact, this seems to me to be the very hot-bed as it were, or happy hunting-ground of this Cecid. It is, however, only part of an end rigg or headland, but it shows where amongst all the others the situations in which they most delight are."

On the 29th of July, Mr. Francis Percival, of Thornhaugh, Wansford, Northamptonshire, forwarded samples of Hessian Fly infestation in Barley, mentioning that he found it was eating the straw in two and doing much damage.

The straw I found to be *very* poor, with one *puparium* or "flax-seed" on each stem, and the straw bruised or broken away close to the point of infestation.

During the past season several instances have been sent of straw which was (or had been) infested, being much injured above the point where the maggots had fed, the stem being broken or torn into ribbons, or bruised in a way which did not seem at all attributable to effect of Hessian Fly attack, even if several maggots had been present, much less where there was only one. The only explanation that suggests itself appears to be that of small birds, or possibly insect-feeding mice, tearing at the spot to get at the "flax-seeds." But at present I am without any evidence as to the cause of the injury, and it would be very desirable to make this point out, for the state of things does a good deal of harm.

At the same date, that is, the 29th of July, Mr. Edm. Riley, writing from Hessle, near Hull, reported the Hessian Fly infestation as not present in that neighbourhood, and as not amounting in any case to as much as one per cent. near Goole, where he had examined the infested crops.

Mr. Riley wrote:—"I have not yet seen any here, but at Goole, where we found it three years ago, you could find it in several fields a fortnight ago. The damage is so immaterial that I thought it not worth while mentioning it. The Wheat in that district (warp-land) grows so strong that you find it when the stem is *not* broken down,

I should say that in no case is one per cent. damage done, as the Wheat ripens as well where the insect is on such land, where the attack comes late."

On the 4th of August, Mr. Riley further reported, "I have not found the Hessian Fly here, only at Goole this year."

The following letter, sent on July 30th, by Mr. Geo. Malden, of Cardington, Beds., is of interest, as giving some amount of estimate of damage since the first observation of Hessian Fly attack in that neighbourhood in 1887. Mr. Malden observed:—"So far this season I have only just walked in a Barley crop for about five minutes when I saw four or five straws that were attacked. This is the fourth season I have noticed it among our crops. In 1887, both Wheat and Barley were somewhat seriously attacked, and upon counting I estimated the damage between $1\frac{1}{2}$ and 2 per cent. I believe that was the first noticed in this district. Both in 1888 and 1889 it was to be found in all fields, though considerably less than in 1887; probably .5 per cent of the straw were attacked."

A few days later (on August 2nd), Mr. Malden wrote further, mentioning the very small infestation to which the Hessian Fly presence amounted, even where he noticed it in all the fields examined. Mr. Malden wrote:—"I have suspected our crops and some of our neighbours', and, though the Hessian Fly is to be found in all Wheat and Barley fields, there is not nearly so much as the last two years, and can only be called a trace."

On the 31st July, Mr. W. McCracken, late Professor of Agriculture at the Royal Agricultural College, Cirencester, sent the following note from Crewe, Cheshire; and here, as in most of the above observations, it will be seen that the damage was not considered to be serious:—

"I am sorry to have to report that the Hessian Fly is once more at work in this neighbourhood. Yesterday and the day before I found specimens of the 'flax-seeds' in the only two fields I examined. These were about 17 miles apart, one at Sandbach in Wheat, and one at Spurston in Barley. The latter field is the same in which I found specimens last year amongst Wheat. In neither case had any damage of consequence been done."

On the 5th of August, Mr. McCracken further added:—"Since writing to you I found the Hessian Fly at work in a field of Wheat not far from Market Drayton, in Staffordshire, just over the Shropshire boundary."

On the 1st August, Mr. T. Freke Lewis, of Abbey Dore, Hereford, forwarded specimens of straw much bruised, broken, and brown. Where the Hessian Fly chrysalids were noticeable they appeared quite small or crushed. In one case the "flax-seed" lay as usual a little above a joint, and a little above it the stem was cleanly bitten about

half through. This was one of the cases of injury noticed at p. 34, of which the cause is not at present clear.

On the 8th August, Mr. D. D. Gibb, writing from Ossemsley Farm, Lymington, Hants, mentioned that he found, on examination of Wheat and Barley on Major W. Murray's property at Ossemsley (Christchurch) and Wootton (of which he had the management), that he had proof of presence of the Hessian Fly in both places; and he further noted:—"From the boisterous and wet weather the crops present a tangled and twisted appearance, and it is therefore difficult to pick out infested plants, as these in many cases do not present such a blighted appearance where they are attacked by Hessian Fly as from other causes."

The following note, with which I was favoured, on the 5th August, by Sir J. T. Stewart Richardson, Bart., of Pitfour Castle, Perth, is of especial interest, regarding effects of soil on amount of presence of the Hessian Fly:—"The damage by Hessian Fly both to Barley and Wheat in this district this year is very considerable. The puparia in the Wheat straws seem to have fallen out to a large extent, but those in the Barley seem all yet firmly lodged in the straw. The attack is only on the crops in the black land, and not on the clay; so much so that in one Wheat field the damage is great at one end, and the clay end is free. We have had no attack since I wrote to you in 1887."

On the 8th August, Mr. Eardley Mason, writing from near Alford, Lincolnshire, mentioned:—"The Hessian Fly is doing more harm than I at first thought probable, comparing this year's attack with those of previous seasons. The harm is less in respect of the actual loss of grain than in the entangled state of the crop, where there is any considerable amount of fly, rendering the harvesting anything but clean. Cut-off ears strew the ground, and are seldom gathered up."

The latest note of observation of the presence of Hessian Fly in the standing crop was sent me, on August 20th, by Mr. Arthur Smith, from Smallford, St. Albans:—"I am writing just to inform you that the Hessian Fly is in existence in the Wheat here, but have not yet discovered any in Barley. The damage done is small."

Where direct estimate of amount of injury is given in the above observations it will be seen that the highest sent (on the 30th of July) only amounted to "Barley: number of attacked stalks in a square yard about two in well-grown crop, ten in shortish thin crop. Wheat, say from two to five in square yard." The other returns, excepting that from the neighbourhood of Perth, in which the damage is noted as very considerable (but even in this case is mentioned as only occurring on kind of land specified), stand as follows:—

"Barley: damage slight, a few stalks here and there broken down,

Wheat : no perceptible damage." "No damage noticeable." "Larvæ and puparia in every field, but sparingly." "In several fields, damage immaterial ; in no case one per cent. of damage done." In two localities about 17 miles apart, "in neither case had any damage of consequence been done."

In the observations of the past as well as of those of previous seasons, the vigorous and healthy state of the crop is noticed as an important help in lessening amount of attack, or consequent injury, and a few observations are given as to results on various kinds of soil, or where nature of locality, as shade, affects the health of the crop.

Full details of the method of Hessian Fly attack, and also measures found useful both for lessening amount of infestation, and for lessening its injurious effects on the attacked Corn, have been given so repeatedly since the autumn of 1886, that they are thoroughly before the public.

Destruction of infested screenings.—Some remarks, however, may still be usefully made in confirmation of the most important preventive measure of all, namely, destroying the "flax-seeds" (that is, the chrysalids or puparia of the Hessian Fly), when they are thrown down by thrashing-machines amongst the light screenings from infested Barley or Wheat straw.

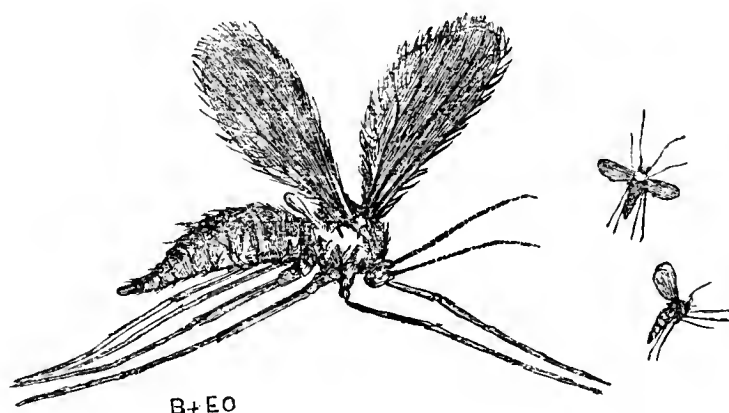
In these circumstances, what (according to our own treatment) will or will not be the origin of future attack, lies in our own hands. If the light screenings with their contents are destroyed (which may be done with no loss of material, and scarcely any labour) there is a clear end of the matter. If, on the contrary, the screenings are preserved, the insect contents, whether Hessian Flies or their parasites, will go forth, and we allow another year's mischief to take place.

The parasite attack does not prevent the infested pest living on the straw up to the change to the chrysalid or flax-seed state,* so that it appears to make little difference practically whether the Hessian Fly maggot damages the straw simply for its own feeding, or to support in addition the parasite maggot within it. In either case we submit to another year's attack which might have been spared.

Another form of the same plan of preservation which has been theoretically advocated is breeding the various contents of the flax-seeds, and selecting the parasites to turn loose. But this would involve great risk. None but well skilled entomologists can tell with certainty amongst these excessively minute creatures whether it is pest or para-

* This point is clearly shown by the observations of Dr. C. Lindeman, the great Russian authority on the habits of the Hessian Fly, who has himself bred the following parasitic flies from Hessian Fly puparia, namely,—*Merisus intermedius* ; *Tetrastichus rileyi* ; *Semiotellus nigripes* ; *Eupelmus karschii* ; *Platygaster minutus*, and *Euryscapus saltator* ; all these species have been identified by Prof. C. V. Riley as present parasitically in this country.

site they may propose to turn loose in our crops, and the most serious consequences might be expected to ensue.



Hessian Fly, nat. size and magnified.

On this point we have the advantage of a very clearly expressed opinion from the excellent authority of the Entomologist of the Dept. of Agriculture, U.S.A. Prof. Riley states :—"At present, and with general entomological knowledge in its present state, there can be no doubt that it will be advisable to burn or otherwise destroy screenings which examination shows to contain puparia. It is a great bother for any one to breed parasites, and for a practical man it is out of the question." *

No observations were sent me of presence of the attack in the autumn-sown or winter Wheat.

Winter attack.—As yet I have received no information of winter attack of Hessian Fly being present, that is to say the form of attack caused by the Hessian Fly laying her eggs on the young autumn Corn shortly after it has come up, which attack is necessarily quite distinct in form to the summer infestation.

Presence or absence of this is of enormous importance, as so long as we do not suffer from this not only is the growing crop safe, but we are spared the increased amount of multiplication which would otherwise have taken place. It may therefore be of practical interest to give some special observations as to the appearance of the infested crop.

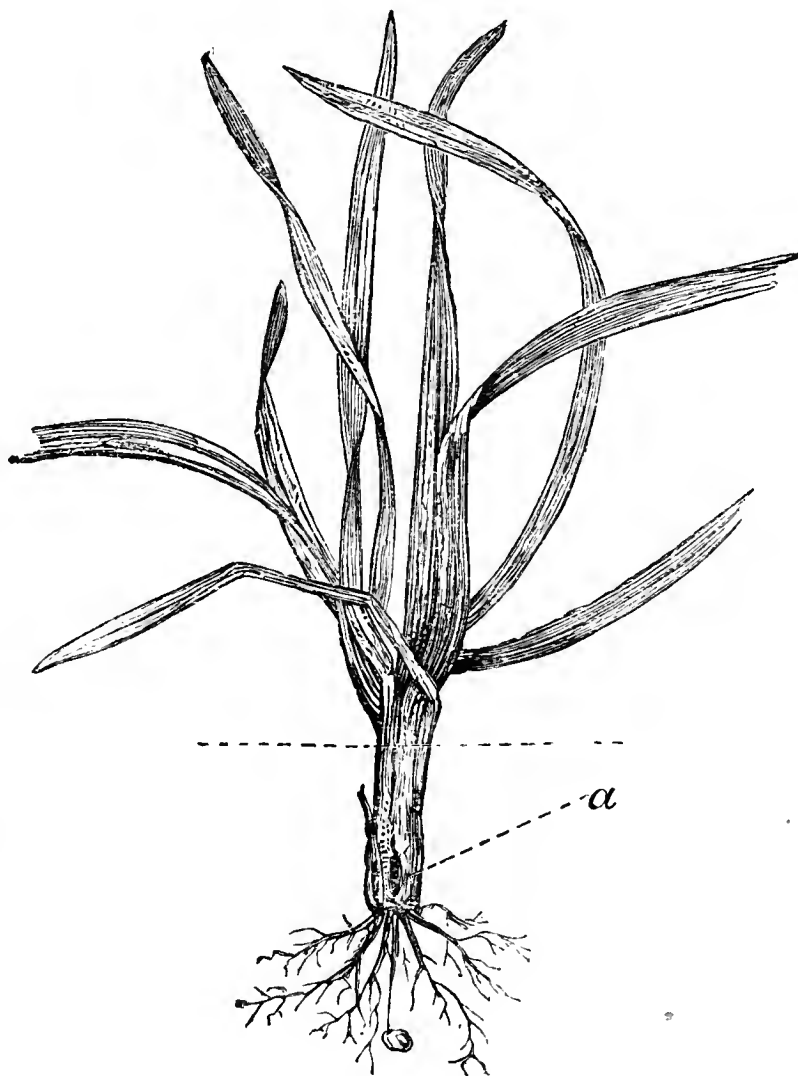
The fly is stated to lay her eggs at the sheathing base of the leaves of the young plant, just above the roots or near the surface.

The appearance of the attacked plant is described by Prof. F. M. Webster, of Lafayette, Ind., U.S.A., in his circular on Hessian Fly, with figure (now given opposite) showing the fly maggot at "a."

"The plant itself has not tillered, the leaves are of a *darker* colour than those of a healthy plant, and proportionally broader. The central spindle-shaped leaf is missing, and the whole plant is only a

* 'Insect Life': periodical Bulletin of U.S.A. Dept. of Agriculture, March, 1889, p. 294.

bunch of rank-growing leaves. In any case the darker colour of the leaf and the absence of the central leaf, together with the bunchy appearance of the part affected, will readily distinguish a fly-infested plant from one not injured. The yellow colour of some leaves is seldom observed at this season of the year on fly-infested plants."



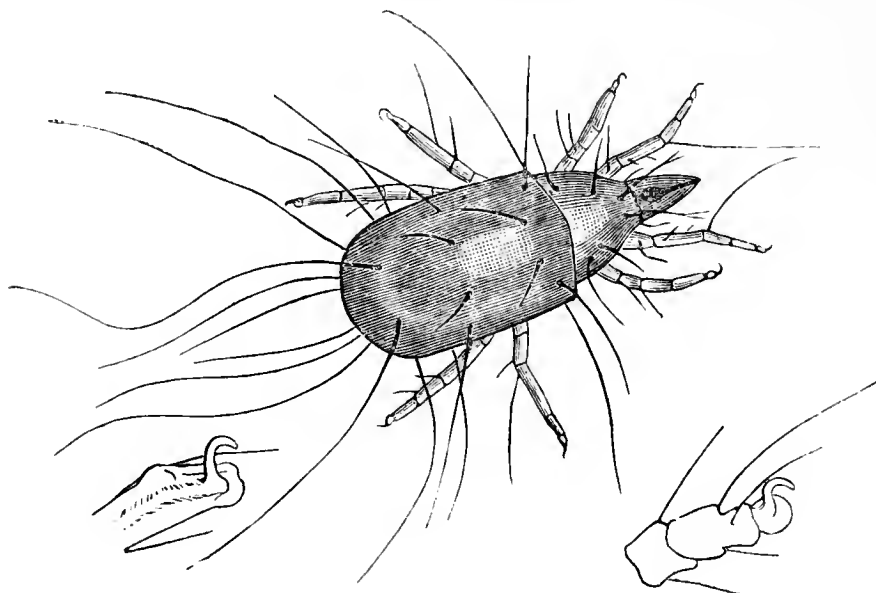
Dr. Lindeman states:—"At first scarcely any stoppage in the rate of growth is to be observed, as is the case in a long continuation of drought, but soon the young plants begin to wither and at last die away; also the plant leaves commonly all wither at the same time, with but very little change of their green colour. If we examine the dead plants closely, we find that neither leaves nor stem are gnawed, that the root is healthy, regularly developed, and branching, and that there are no traces of the characteristics of insect-feeding known as worm meal.

"The plant appears killed as if by being simply dried up. Low down by the root it is commonly swollen, and here, in the axil of the leaf, is either the maggot of the Hessian Fly, or still more frequently the puparium itself, in appearance a brown elliptical shining body extraordinarily like a flax-seed.*

The above descriptions may serve as guides as to existence of winter infestation, or conditions where it has been.

* Die Hessenfliege (*Cecidomyia destructor*), Say, in Russland, von Dr. K. Lindman, Moscow, 1887. (Eng. Trans. M.S., by Georgiana E. Ormerod, pp. 22, 23.)

Mites (in Hay). *Tyroglyphus longior*, Gervais.



TYROGLYPHUS LONGIOR.

T. longior (from fig. by Fumozze and Robin): claw and sucker of *Tyroglyphus*, right-hand side (from Murray's 'Aptera'); claw and sucker on left-hand side, figured by ED. from life. All magnified.*

In the course of November (in 1886) specimens, or rather small masses of Mites (or *Acari*), were forwarded to me by the Editor of the 'Farmers' Gazette,' Dublin, on the part of Mr. T. Robinson, Land Steward to Sir John Gough, Knockcreven, Clonmel, with the information that they were dropping in great numbers from the sides of a hayrick, and the precise name and nature of the infestation was wished for.

The Mites did not appear to me to differ from the kind of "Cheese Mite" scientifically known as the *Tyroglyphus longior*; but, as I had not especially studied the *Acari*, and the presence of Cheese Mites in a haystack was then an entirely new observation to me, I distrusted my own views, and suggested that application should be made to Mr. Albert Michael, F.L.S., as a most trustworthy authority.

Mr. Michael found on examination that the Mites were, as supposed, the species of Cheese Mites known as the *T. longior*, and further added much valuable information, which, by the courtesy of the Editor of the 'Farmers' Gazette' in having the communication copied for me, I give on the following pages. I did not insert the observations in my Report for 1886, as I was not then aware of it being other than a quite exceptional occurrence.

Since then, however, notes of another apparently similar attack were sent me, and at the beginning of October of the present year (1890) I had again notes sent of the presence of what appeared to me to be precisely the same kind of Mite dropping in vast numbers from

* The real size can hardly be conveyed so as to give any clear idea. It is rather more than half the 25th of an inch in length.

hay stored in a loft. Under these circumstances the attack proves of sufficient practical interest to notice.

The general appearance of these Mites may easily be seen by any one who will examine a little of the living dust-like matter often to be found in old cheese, by placing it under a microscope or fairly strong magnifying glass. The order of *Acarina*, or Mites, are mostly very minute, and are distinguishable from insects in any stage by their very minute size, and by having head, body, and abdomen all in one piece; they are for the most part furnished with four pairs of legs when they are full-grown, three pairs when they are just hatched.

The subfamily of the Cheese Mites (*Tyroglyphidæ*) is more especially distinguishable by the fleshy soft whitish body, somewhat elongated in form, with conical proboscis; the jaws shaped like crabs' claws (chelate); and the legs five-jointed, terminating in suckers or lobes for fixing themselves with. Amongst these *Tyroglyphidæ* the sub-genus *Tyroglyphus* is distinguishable by having *one* claw, as well as the sucker at the end of the leg; and amongst these *Tyroglyphi*, the *T. longior* (the kind we have found in hay, although its special attachment is to various kinds of cheese) is distinguishable from the *T. siro*, the "Common Cheese Mite," by being larger, longer in proportion, furnished with much longer and more shining hairs, and also by being much more rapid in its movements.* The rapid movements and the great length of the hairs are very easily observable microscopically.

The figure at the head of this paper shows the numerous and long hairs, the crabs' claw-like jaws, and the single claw, with the fine sucker ("like a sleeve") surrounding it at the end of the tarsus or foot. The claw drawn (magnified) on the right-hand side is from the figure given in Murray's 'Aptera,' p. 256, of a tarsus of the genus *Tyroglyphus*; that on the left hand is from a sketch taken by myself of the tarsus, or rather the extremity of the tarsus, somewhat more magnified, of the specimens sent me this year (1890). It will be seen that the shape of this claw and the outline of the sucker precisely correspond with the other figure; but I noticed the apparatus running up the foot for moving the claw more distinctly than appears in Mr. Murray's figure, and I did not observe the cross-line apparently intended to show a joint. The other characteristics noted were very plainly observable in the specimens sent me.

The first specimens, namely, those authoritatively identified in 1886 by Mr. Albert Michael, together with the observations of the nature of the attack sent by Mr. T. Robinson, and also some general considerations on the habits and means of prevention of the pest, are

* For notes from which the above short descriptions of characteristics are condensed, see Claus and Sedgwick's 'Elementary Text-book of Zoology,' and 'Aptera,' by Andrew Murray.

given at length in the following reprint of the correspondence from the 'Farmers' Gazette' (Dublin), Dec. 25th, 1886, for which I am indebted to the courtesy of the Editor, Mr. W. Hooper.

As I mentioned above, the letters and specimens were first submitted to myself for examination; but the infestation of Cheese Mites being then unknown to me as occurring in such a very abnormal situation, I did not like to rest on my own views until they had been confirmed by the sound authority of Mr. Michael :—

“MITES IN A HAYRICK.—Recently a small wooden box, about half the size of a small egg-cup, was sent us completely full of Mites, with the following note, intended for our query column :—

“‘I have a rick of hay, from the sides of which there are numbers of the enclosed dropping out. What is the cause? Is it safe to feed stock with the hay?’

“Both to the naked eye and under a powerful microscope these minute creatures bore a very great resemblance to ordinary Cheese Mites, and on placing a piece of cheese near them it was soon discovered that they were eating it. We had heard of forage Mites being found in old hay, but had no personal experience of them, and thought it very improbable that the same *Acarus* would live on hay and cheese. We, therefore, wrote to the querist, Mr. T. Robinson, land steward to Sir John Gough, Knockcreven, Clonmel, for further particulars, and received the following reply :—

“‘In reply to your letter of yesterday regarding Mites in hayrick, I beg to state that there cannot have been a mistake about the specimens forwarded to you, as I took them up and put them in the box with my own hands. There is no decaying substance in the rick, other than the hay, a sample of which I forward to you this day by parcels post. It is second-crop hay, which was cut about the 20th August, and saved without rain; but it remained some time in cocks in the field. The outsides got a little damaged from heavy rains. I think the whole rick is infested with them. They seem to be more numerous near the ground than at the roof, but that might be caused by the working downwards in the hay. The rick was made about seven weeks when I first observed them by the sides of it. The rick heated a little for about ten days after it was made, but only slightly, as the hay is now coming out good.’

“The sample of hay sent was in good condition (except that it was infested with Mites), and had evidently been well saved; it was, in fact, a superior sample of hay. Having procured another small box full of the mites from Mr. Robinson, we forwarded it to Mr. Albert D. Michael, of London, who has made Acarinology his special study, from whom we have received the following reply :—

“ ‘Editor, ‘Farmer’s Gazette’:—I have examined the *Acari* accompanying your letter of 6th inst. There are more than one species of Mite among those sent, but far the greater bulk appears to be “*Tyroglyphus longior*” (Robin and Fumoze); the others are in such small numbers that they may be neglected. *T. longior* is, as you evidently suspect, one of the Cheese Mites. The ordinary well-known Cheese Mite is *Tyroglyphus siro*, a species so like *T. longior* that it is difficult to distinguish the two. *T. longior* also lives in cheese, often in company with *T. siro*, and is frequently the more abundant of the two; they do not, however, either of them, confine their attention to cheese. *T. siro* thrives and multiplies equally well on flour, linseed meal, &c., provided other conditions be favourable; and, indeed, both species, and many of their allies, will attack an immense variety of dead and dried animal and vegetable substances; but they do not, as far as my experience goes, attack either in living condition, except that they appear sometimes to eat small fungoid growths; neither do they, as a rule, like substances in a state of decomposition. *T. longior* will thrive only too well on dried cantharides, and causes great damage in parcels of that material.

“ ‘It is the characteristic of these two species, and some of their allies, that occasionally, when they find conditions thoroughly favourable, they increase to such an enormous extent that the substance they are feeding on seems to be wholly composed of the Mites; and a wholesale druggist lately offered to send me as many pounds’ weight of the Mites as I chose to have. I should think that they were probably accidentally introduced into the hayrick (they are generally distributed), and that happening to find conditions of moderate warmth, slight damp, and appropriate food, which just suited them, they have increased to an extreme, but not altogether exceptional, extent.

“ ‘I do not see any reason why cattle should be injured by eating them. We, ourselves, are not injured by eating them, which we do in great numbers in cheese. Moreover, the fodder in warm stables and cow-sheds is generally pretty abundantly supplied with this and other allied species, but the horses and cows do not suffer from the circumstance, as far as we know. The only way in which it strikes me that they might be injurious is this,—that where minute creatures, like this, are in such immense abundance, as in the present instance, very large numbers are apt to get upon anything, whether living or dead, that is long amongst them; and although they are not in any way parasitic, yet the mere friction of such multitudes of minute claws, and of the fine hairs with which the creatures are so well supplied, often mechanically produces considerable irritation of the skin for a time; thus, porters engaged in unloading grain, and other things very much infested with allied creatures, have sometimes been

affected with severe itching for a time, and have even refused to continue their work, on the ground that the grain was (as they thought) poisonous. This is a trifling matter with human beings; but with animals, which cannot clear themselves quite so readily, it strikes one as just possible that it might induce them to rub themselves, &c., until they set up more serious evils, and might keep them in a state of unrest. I have not, however, any knowledge of such a thing having actually occurred.

“ ‘ Finally, Mr. Robinson would, doubtless, like to know how to get rid of the creatures, and I fear I cannot help him much. I do not see how they can be eradicated from the rick, if it be deeply infected. If it could be pulled to pieces, and the hay in a loose condition exposed to dry heat, they would be killed, although even then it is possible that some eggs might survive; but this process would probably not be worth doing. At any rate, as the creatures in such abundance unquestionably do a good deal of damage, I would suggest that it would be well to try and limit the damage for the future, by burning all refuse of the rick and all sweepings round it, and infected matter on the spot, and not carrying them about, or throwing them upon rubbish heaps.’ ”— (Albert D. Michael.)

Another very similar observation was sent me subsequently from another quarter, of which I am not now able to give the full details; but in the course of the past autumn I received the following enquiry, accompanied by myriads of the Mites, and also some of the Grass tops, through the hands of the Editor of the ‘Farming World,’ Edinburgh:—

“ Sir,—We have this day forwarded by post, box containing sample of ‘Mites,’ or insects like Mites, which are dropping in large quantities out of a lot of Rye-grass hay, bought by us some time ago. Hay this season’s growth, first cut, got in good order, local grown. We have stored it in a large, airy loft, but at doors and windows these vermin are dropping in shovelfuls. May we venture to ask your opinion as to the effect this may have on the hay, if it may be given to horses without fear of any evil results following its use? So far the horses are eating it quite freely.—J. A. H.”*

On most careful examination of these Mites with various microscopic powers, I found them to agree in every respect which I could distinguish with the “longer” and long-haired kind of Cheese Mite, the *Tyroglyphus longior*, previously identified, and figured at the heading. But still we do not know (so far as I am aware) either what is the reason of the occasional appearance of these Mites in the hay-ricks, or in hay in a “large airy loft,” nor yet how we are to get rid of them.

* See ‘Farming World’ Edinburgh, number for October 3rd, 1890, p. 631.

It is noticeable in the above account that the creatures did not appear at home in their quarters, for it is observed that "at doors and windows these vermin were dropping in shovelfuls." Also in the observation given by Mr. Robinson, at p. 42, he remarks that numbers of the Mites were dropping from the sides of the hayrick. These points suggest whether the Mites would have migrated and left the hay clean?

They dislike airy, dry situations, so that the airy loft would, on the face of the thing, be the kind of place from which they would be likely to remove. But we need further observations as to method of life; and especially, where found in lofts, whether there were any dairy buildings or other places near, from which they could have migrated.

As they multiply by hatching from eggs, a thorough purification of the floors, walls, and roofs of an infested loft would be highly desirable, as soon as it was emptied, in order to destroy all eggs and hatching, or young Mites. Probably nothing would answer this purpose better than a good whitewashing of everything accessible, for the bright white colour, would at once show whether the work was thoroughly done or not. It would require good overlooking to ensure that the wash should be well got into all holes and corners, as these are the places which the Mites would most frequent, and which the whitewashers would the least attend to.

Where the Mites drop in the myriads noticed to the ground below, it would be desirable (and would cost little) to lay a strip of rough cloth or old oil cloth, or anything of the kind which might carry a good stripe of wet tar on it, just below where the Mites were dropping from. Thus any further annoyance or inconvenience would be prevented, at least from these; but with regard to clearing the infested Hay I have as yet no reliable information.

As the Mites dislike light and air and dryness, it would appear likely that if each day's fodder could be lightly shaken up into a kind of haycock some time before use, they would at least go down to the lowest part of the heap, and free the rest of the fodder. But this is only conjecture. Any practical means for getting rid of this infestation, which is disagreeable even if it is harmless, would be very desirable.

Stem Eelworm. *Tylenchus devastatrix*, Kuhn.



Young plant of Tulip-rooted Oats.

The diseased growth known as Tulip-root, or Segging, in Oats, is now so very well known both as to cause and methods found very serviceable both for prevention of recurrence of the attack, and to check it when present, that it hardly appears to require further notice. But from amongst the reports sent in during the past season I select just a few observations showing the great harm to the Oat crop sometimes caused by this attack.

As has been before noticed in this series of Reports, this disease consists of a sedge-like growth of the leaves, or a kind of bulb-like growth of the base of the stem of the Oat plant, with a number of minute pale crinkled shoots massed round the somewhat *Tulip*-bulb formed enlargement. These growths are caused by the presence of the Stem Eelworm, the *Tylenchus devastatrix*, of the attacks of which to Clover and to Field Bean plants, notes are given at pp. 16—22, preceding.

On the 9th of June, Mr. James Harper, writing from Auchnabo, Slains, Ellon (Aberdeenshire), mentioned that he was again troubled by Eelworms infesting an 8-acre field of Oats on the same land which was infested two years ago, and was the worst attack he had ever seen. "I think there is scarcely a plant escaping attack."—(J. H.)

On the 30th of June, Mr. J. Gathorne Wood, of Thedden Grange, Alton, Hants, forwarded me specimens of Tulip-rooted Oats with the remark that in one field he had several acres of Oats almost destroyed by the infestation.

The following observation sent early in August by Mr. John Hellaby, from Harlaston, near Tamworth, notes attack on a still wider scale, and gives an example of the patchy manner in which this kind of Eelworm attack often occurs, varying from infested spaces of several

acres (as mentioned below) down to little spots a yard or so across scattered over one field.

The Tulip-rooted Oats sent were reported by Mr. Hellaby as being from a thirty-acre field on strong marl land, which was badly affected by the disease in patches, almost to not getting the seed again. In some parts of the field the crop was good, in others patches of two or three acres apiece were affected. The field had been sown with Oats and Clover after Turnips and Cabbage.

Mr. John Elder, of the Holmes, Linlithgow, whose yearly observations have greatly helped us to a knowledge of serviceable observations both for prevention and remedy of this attack, wrote me in a report on insect pests of the past season, sent in October:—"The Eelworm (Tulip-root) showed a little in some fields, but did not do any serious damage. In my own case I never had as heavy Oat crops, and the only portion that showed signs of Tulip-root was a small bit left unmanured. My manure was $1\frac{1}{4}$ cwt. sulphate potash (55 per cent.), 2 cwt. phosphates mixed, and $1\frac{1}{4}$ cwt. sulphate ammonia, per acre."

This mixture is the same in constituents, though with some slight differences in proportion as that previously found by Mr. Elder to answer extremely well in 1888 in keeping Tulip-root in check, and giving a luxuriant growth.*

Various experiments, with various results as to success or failure, were reported, but from the mixed nature of applications named (including, in some cases, what we know would certainly be useful, as well as what was very uncertain), to report these experiments would scarcely be of service.

Mr. J. Harper, of Auchnabo, above quoted, mentioned that he ploughed deeply (a most desirable preparation on infested land, Ed.), and also gave 1 cwt. nitrate of soda and 1 cwt. sulphate of potash; and the Oat crop at date of writing was fairly recovering and doing well towards a good return. In this case the sulphate of potash would, from the results of many experiences, do well; but, so far as I can myself judge, I should say previous experiments in this country did not point to nitrate of soda being a trustworthy remedy for Eelworm attack.

Notes on treatment of this attack, both by ordinary agricultural measures and by special applications, are given in my Reports from 1886 up to date; but as the yearly observations now show a constant increase in the number of kinds of plants liable to the infestation (notably Field Beans in this country, and Potatoes on the Continent of Europe), I repeat once again, from my 13th Report, the magnified

* See 'Manual of Injurious Insects,' by Ed., p. 103.

figures of the male and female Stem Eelworm, the *Tylenchus devastatrix*, which I am permitted by the courtesy of Dr. J. Ritzema Bos* to copy from his figures drawn from life. These figures and the following explanation of the plate give all the details requisite for microscopic identification.

EXPLANATION OF PLATE.

FIG. 1. *Tylenchus devastatrix*, female, taken from an Onion plant; magnified 200 times.

a, spear; *b*, first muscular swelling of the œsophagus; *c*, second œsophageal ring; *d, e*, intestine, properly so called; *e, f*, rectum; *f*, anal opening; *g*, excretory pore (orifice of the lateral vessel); *h*, commencement of the ovary; *i*, ovule, with nuclei (or germs), not fertilised; *k*, first half of the oviduct (tube), with spermatozooids; *l*, second half of the oviduct, with glands in the wall; *m*, anterior portion of the uterus, containing a fertilised egg; *n*, sac, with closed extremity, second portion of uterus; *o*, vulva.

FIG. 2. *Tylenchus devastatrix*, male, taken from an Onion plant; magnified 200 times.

For *a, b, c, d, e*, and *g*, see explanation of preceding figure; *f*, cloacal opening; *h*, commencement of the testis; *i*, mother-cells of the spermatozooids (Spermatoblastes); *k*, cells further divided, forming spermatozooids; *l*, vas deferens; *m*, spicule; *n*, accessory piece; *o*, purse.

FIG. 3. Anterior portion of a *Tylenchus devastatrix*, not fully developed, taken from an Onion plant; magnified 440 times.

For *a, b, c*, and *d*, see explanation of fig. 1. In front of the spear (*a*) is shown the labial region, and lower, at the base of the spear, the *musculi protractorii* leading forwards, and the *musculi retractorii* leading backwards. The half of the œsophagus in advance of the first bulb, or muscular swelling (*b*), has a straight direction; the half which extends from the first to the second muscular swelling is waved. In the second bulb nuclei are visible. Near (*d*) the intestine begins; in the wall of this the separate cells are not distinguishable, because of the presence of the numerous drops, which refract the light strongly.

FIG. 4. Anterior portion of a *Tylenchus devastatrix*, taken from a Wheat plant; magnified 440 times.

FIG. 5. Eelworms from Hyacinth, dried and rolled together.

FIGS. 6 & 7. Eggs of *T. devastatrix*, showing an early and late stage of formation of the embryo.

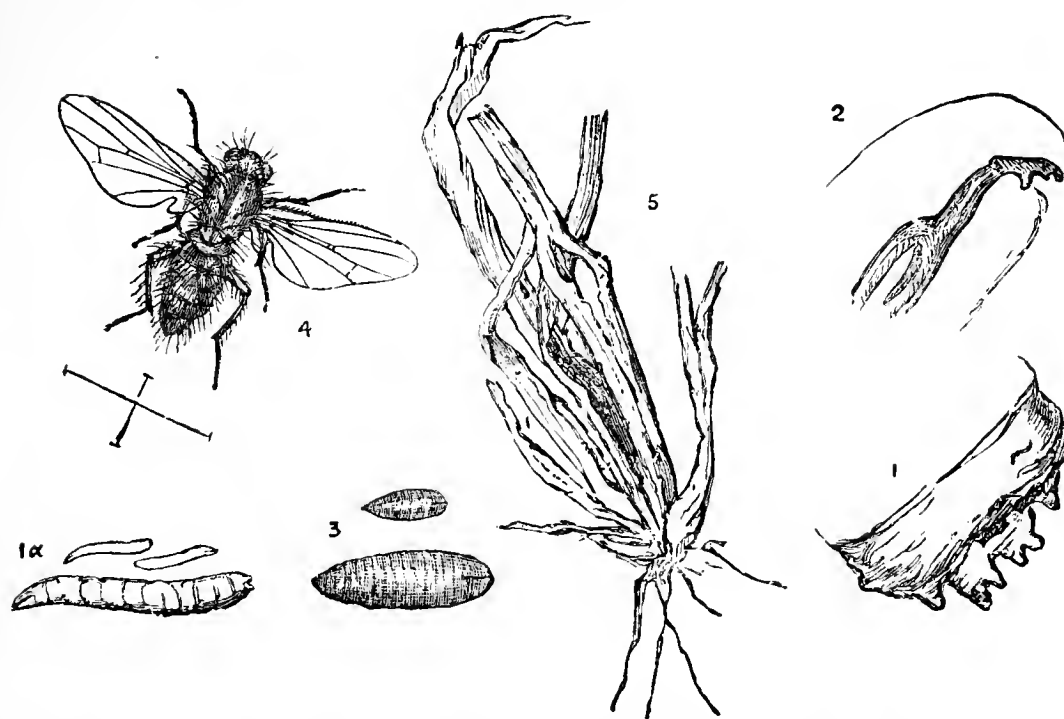
FIG. 8. The young wormlet (*T. devastatrix*) newly emerged from the egg.

FIG. 9. Egg of *T. devastatrix* before segmentation of protoplasm.

The figures on the plate are all greatly magnified. The life-size of the male and female is 1.5 mm., that is, a little more than the 25th part of an inch.

* See Plates I. and II. in 'L'Anguillule de la tige (*Tylenchus devastatrix*, Kuhn), par Dr. J. Ritzema Bos, Prof. a l'Institut Agricole de l'État à Wageningen.

Wheat-bulb Fly. *Hylemyia coarctata*, Fallen.



Wheat-bulb Fly (*Hylemyia coarctata*), magnified, and lines showing nat. size; maggots and chrysalids, nat. size and mag.; mouth apparatus, and extremity of tail, with tubercles, mag.; infested plant.

During the past season, only a few observations of Wheat-bulb Fly were forwarded, but such reports as I received were from localities so far from each other as to show the infestation to be widely distributed, and they also showed that the kind of attack was the cause of very serious injury.

The damage is caused (as mentioned in previous Reports) by the small, whitish, legless maggots (figured above) feeding within the young Wheat plants early in the season, and so destroying the infested shoot; and, as the mischief that is going forward is rarely known of until attention is drawn to it by the withering of the shoot in which the maggot has been feeding, it is then too late to do much to help the failing crop.

The presence of infestation is noticeable at the beginning of April, or some weeks earlier. About the middle of May maggots may be found beginning to change to the chrysalis state in or near the decaying shoots ruined by their attack, and about the beginning of July, in such cases as I have seen, the fly makes its appearance. This may be generally described as a greyish hairy two-winged fly of the shape figured at the heading.*

Up to this time we do not know whether there is a second or summer brood. It does not seem likely that the flies which hatch out in July should live on to infest autumn and winter Wheat, sown, as for instance in 1889, at dates of which we have record in October,

* For descriptions of the perfect insect and larva, see my 'Twelfth Report on Injurious Insects,' pp. 80, 81.

November, and at the end of December, "that sown on the 27th of December being afterwards entirely destroyed."

But at present all the clue we have to their summer habits is the fact noticed in the observations of each successive year of the special appearance of the attack after fallow, or bare or summer fallow, or after Turnips or Swedes, or where a portion of these have failed, or after Potatoes have been raised early, or had thin amounts of leafage. This inclines me to think that the summer attack may be in young plants of Couch or other wild Grasses, such as might be likely to grow on half-bare ground, or on fallows, in the condition in which I have at times seen them; but we have no evidence as yet on this point.

The first communication I had in the past season was from Mr. T. Spencer Smithson, of Facit, Rochdale, who wrote me on March 18th:—"The Wheat-bulb Fly, I am sorry to say, has again done serious damage in the same district of Lincolnshire as I reported to you last year." [This was on a farm at or near Saxilby, in a district a few miles north-west of Lincoln.—ED.] "But this time the attack is more noticeable on Wheat sown after Clover and Rye-grass. This seems to me to afford some confirmation to your theory that the presence of Grass on the land previous to the sowing of the Wheat has some connection with the attack. The pest has apparently begun its ravages much earlier this year than last, and I am afraid the time has gone by for making satisfactory observations, as, when I was in Lincolnshire last week, the maggots themselves had disappeared."

On the 24th of April maggots, nearly or quite full-grown, were sent to me from Rochford, Essex, by Mr. Arthur L. Harrington, with the note:—"I send you herewith two or three maggots, which are found in the crowns of some Wheat on marsh lands; they are doing much damage. Can you give any account of them?"

A few days later, on the 28th of April, Mr. C. C. Harvey, writing from Foulness, Essex, forwarded specimens both of the *H. coarctata* maggots and of the Wheat which the maggots were destroying on his farm, with the mention that it was doing a deal of hurt on much of the marsh land on the Essex coast.

The following notes show the rapid change in an infested crop from the damage not being observable under special inspection, on the 4th of April, to severe injury, and half being destroyed by the 1st of May:—

On the 30th of April, Mr. J. Eardley Mason wrote me from Alford, Lincolnshire:—"On the 4th instant I inspected the Wheats upon the farm at Cumbermouth, near Alford, where *Hylemyia coarctata* did so much damage last year. I could then detect no visible signs of damage, but yesterday Mr. William Dring, the occupier, told me that precisely the same attack as last year has shown itself extensively in a

field adjoining. It is after fallow again that the attack comes. Mr. Dring knows the form of attack and the maggot well."

On the 4th of May, Mr. Eardley Mason wrote to me further on the subject:—"I inspected the field at Cumberworth, which I spoke of. The change in its appearance is great. On the 4th of April a full healthy plant with no outward sign of attack: on the 1st May a scene of destruction. Over the greater part of the field one-half the plants are destroyed, and that past redemption. The larvæ were very nearly full-fed, but not many, I think, had pupated, for no puparia were found."

The above notes, it will be seen, refer to presence in the East of England. On the 2nd of May specimens of Wheat plants infested by the *H. coarctata* maggots were sent me from the South-west of England—from Corfe Hill, Weymouth—by Mr. E. B. Thresher, with the observation that the maggots were rapidly destroying the infested piece of Wheat. In this case the uninjured shoots were about or upwards of six inches long.

The observations forwarded this year do not help us to any further information as to means of dealing with this attack, but are of interest as showing the serious nature of the infestation; also its continued yearly appearance, and possibly the special presence in the marsh lands in Essex may be worth observation in connection with the report, sent to me in 1888, of hundreds of acres being destroyed by attack of this Wheat-bulb maggot in the Cambridgeshire Fens.

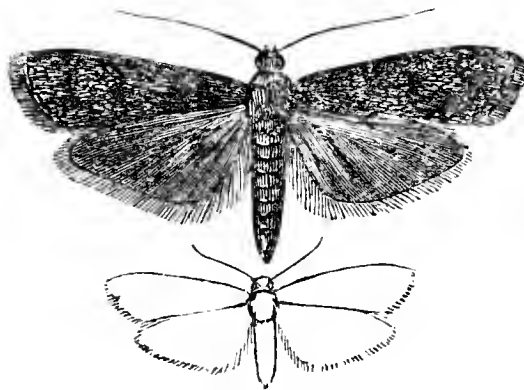
The following precise report of loss on infested crop, with which I was favoured by Mr. Michael Ellison, of Barber Woodhouse, on Dec. 27th, 1889, is a very serviceable addition, as being one of the definite records of direct loss by insect agency, which are so valuable to possess and so difficult to procure. I was sorry not to insert it in the year's report on Wheat-bulb maggot, to which it belongs, but the paper was then in type. I now give it in Mr. Ellison's own words:—

"In our correspondence last year respecting the Wheat-bulb maggot, in one of my letters I used words (quoted in your pamphlet) to this effect, 'I trust that the Corn that remains may yield more abundantly to make up for that which is lost,' It may interest you to know the result of the cropping and yield, which I have just lately learned from the tenant. From one field of $8\frac{1}{2}$ acres there was no 'first' Corn; only 3 loads, or 9 bushels per acre, of 'seconds.' The other field of 12 acres yielded 16 sacks of 4 bushels each of 'firsts,' and of 'seconds' same as above, *viz.*, 3 loads per acre. You will see, therefore, that my wish expressed last year has certainly not been realised, and the results, as above described, show very forcibly what power for mischief the little maggot possesses."

The observations on "Mites" in Hay, and also on the "Flour Moth," the first of which attacks is sometimes very troublesome, and the second almost overwhelmingly destructive in mills and flour warehouses, are given for this reason, though not *growing-crop* pests.

FLOUR MILLS AND STORES.

Mediterranean Flour Moth. *Ephestia kühniella*, Zeller.



EPHESTIA KÜHNIELLA.

Mediterranean Flour Moth, magnified; outline showing natural size.

The "Mediterranean" Flour Moth (as it has now been named), the appearance of which as a most serious infestation in stores or Wheat flour mills, where it could gain entrance, was first recorded in this country respectively in 1887 and 1888, may now be considered to be thoroughly established, and quietly extending itself. From the natural and reasonable objection of all mill owners who are suffering from the presence of the pest to let the trouble be known of, the measures which are desirable to prevent spread of the evil cannot be made known, as is (for public good) highly desirable round the infested centres, and consequently infested meal or flour, and sacks passing to and fro, carry the infestation to neighbouring bakeries, or to more distant points, without the public at large being aware of what is going forward. In this matter my own hands are completely tied, as the requests for information regarding the attack which are sent to myself are sent in confidence, and consequently, however much I may know of the spread of the attack, I cannot give the warnings, which would be little short of ruin to the mill owners who have desired my help.

At present I am aware that at the steam mills where the pest was first reported as present in England it is still a very serious trouble, and, though much expense has been gone to in preventive measures, which have kept it to some degree in check, it is still seriously injurious.

On recent inquiry as to the state of things, I received the following reply from the owner:—"If it lay in my power I should be only too glad to assist in getting clear of the moths: unfortunately I *cannot*. They are here as bad, or worse than ever; so bad, in fact, that I have found it necessary to stop working my mill. I am at a loss to know what is going to be done if the pest spreads, as it seems likely to do.

"I happened some little while ago to be in a large warehouse belonging to one of the Canal Companies, where a very large quantity of grain, flour, &c., is trans-shipped, and I saw plenty of moths flying about there; in fact, I rather think I must have got them from there; so I fear there is little doubt but they will spread."

On the 5th of February, I received an application from a firm in the North of England, on the part of mill owners in a very large way of business in a distant part of the country, in which they mentioned:—"We would like to know how to get rid of the maggots of a small moth which is now becoming a serious practical nuisance in English flour mills. It is supposed that they first came here in a cargo of Russian Wheat, and are now taking up a firm hold in flour mills. Would sulphurous-acid gas be likely to kill them?"

After examination of specimens so as to ascertain that it was absolutely the *Ephestia kühniella* that was present, I forwarded information as to the best known method of treatment, and subsequently received a report from the proprietor as to partial success of measures used, and also misfortune occurring from over-application. These I give further on under preventive measures. But the result was by no means entirely satisfactory, as will be seen in the following letter, sent me on Nov. 9th, in reply to my inquiries:—

"I am sorry I cannot give you a receipt for getting rid of them entirely, nor much information about them. Cleanliness is a great enemy to them, of course, and we have not adopted any stronger measures since giving up the sulphur. I was recently told by some millwrights who were working for us that in some mills the plague is very much worse than we have had it. They mentioned a mill in "[locality named, Ed.] "where moths were excessively numerous and troublesome.

"PS.—I was over several mills in Edinburgh and one at Dundee in July, but did not see any there." (Signed by head of mill firm).

The facts of the infestation being present at large steam mills in widely separated parts of England, it being in the Canal Company's warehouse, as above mentioned, my own knowledge of it being spread round one infested centre to the great annoyance of the neighbourhood, and various lesser observations, besides the overwhelming appearance first recorded in warehouses in East London, show the firm root the pest has taken.

Its geographical spread has been very notable. Last year it gained footing in Canada ; and, whilst I write, I have received a communication from Dr. Selmar Schonland, Curator of the Albany Museum, Grahamstown, Cape Colony, in which he mentions inquiry having been sent to him from King Williamstown, regarding “ a moth (or rather the larvæ) which do great damage in flour mills.” Dr. Schonland was inquiring into the subject, but the probability, even, of the attack being this scourge on its still further advance deserves notice.

The moth is of the shape figured at p. 52, and of the size given in outline, the fore wings of a palish grey with darker transverse markings, the hinder wings whitish and semitransparent.

As it is of considerable importance to be able to distinguish the caterpillars of this well-named “ mill scourge ” from other less troublesome kinds, I repeat below the description which I formed carefully from living specimens in 1888.*

The mischief is caused by these caterpillars getting into every place where flour can fall, and spinning it together with their webs so as to

* The caterpillars varied in size from two-eighths up to five-eighths of an inch in length, and correspondingly in colour, the younger ones being of flesh or pale red colour, and the largest almost white; the shape cylindrical, somewhat slender, with sixteen feet, that is, three pairs of claw-feet, four pairs of sucker-feet, and a pair beneath the tail, by the help of which, although the largest of the larvæ were sluggish, the younger travelled nimbly, and could move backwards or forwards at pleasure, or were able to attach themselves at once to a foreign substance, as the finger or hand. The head yellowish brown, darker in front, and with dark brown jaws; a transverse patch on the segment next the head, this rather pale yellowish brown, with a faint pale central line dividing it from back to front, and (in the oldest specimen) a small brown spot on each side of the segment below the patch. Along the back, excepting towards the head and tail, were four small dark dots on each segment, above, two on each side the centre. On the segments near the head the spots were arranged more transversely, and at the tail, immediately above the sucker-feet, was a brownish oval or somewhat triangular patch (the anal plate). On the preceding segment the transverse row of spots varied somewhat in different specimens; the largest was in the middle, with a smaller one on each side, occasionally one below, which would make five altogether; but sometimes the lowest pair was absent, sometimes the middle large spot was not entire; conjecturally the marking differed with the age of the caterpillar. On the preceding, that is, the eleventh segment, there were two clearly defined brownish spots, and along each side of the caterpillar was a row of dark dots, one on each segment.

The caterpillar was slightly sprinkled with pale hairs or fine bristles, and had such a capacity for catching and retaining a covering of flour that I was obliged perpetually to remove it with the moistened tip of a finger to obtain a clear view of the markings.

The chrysalis, which was lying in a silken cocoon of spun-up flour, showed the chief points of the form of the coming insect plainly; the colour beeswax below, shading to reddish brown on the back, and reddish brown also at the end of the somewhat prolonged, slightly-curved tail, which ended bluntly or cylindrically; the eyes of a darker shade of red.—‘ 12th Report on Injurious Insects,’ by Ed.

cause a most serious difficulty in working the mills; in the words of one of my first correspondents, they "get into the spouts and machinery, and do no end of mischief, both by destroying the silks and stopping the flow of flour, &c., in the spouts by spinning their web and hanging there." In the report of the Canadian mill owners, in whose premises the pest was first found at work in Ontario (and to such an overwhelming amount that the mill had to stop work), it was mentioned the "mill-walls, ceilings, cracks, crevices, and every machine was completely infested with moths, cocoons, and caterpillars, and there was no use going on."*

In the account given in 1887 by Mr. Sidney Klein of the damage caused by this attack in some warehouses in the East-end of London, he mentioned that there were over a thousand tons of flour stored in close proximity, . . . and "the attack spread with great rapidity until one entire warehouse was literally smothered with larvæ, and several hundreds of pounds' worth of damage was done."†

The above short descriptions of the appearance of the caterpillars and their methods of injury are merely given just to convey an idea of the nature of the infestations to those to whom the subject may be new. Details will be found at length in the publications mentioned in footnotes to this paper.

PREVENTION AND REMEDIES.—So far as we see at present, all that can be done in this way lies in the most extreme cleanliness, in fumigation, which, however, has to be done with much knowledge of chemical effects on flour that may be stored near by, and also in application of steam.

What would be the best remedy of all unfortunately appears to be impossible to bring to bear. The infestation takes this enormous hold because the proper food of the caterpillars is always present. If circumstances allowed of change of material ground, for a while, to some other kind of grain or seed on which the caterpillars would not feed, this infestation might very soon be got rid of; just, in fact, on the same principle as Mustard Beetle is got rid of when it has increased so as to be overly troublesome in the Mustard-growing districts in the East of England, by ceasing to grow the crop for a year or two. If the food crop or food material is removed, the feeder is necessarily got rid of, or much lessened in numbers.

Application of Hot Steam.—As, however, the above preventive measure could not be used, I suggested (from previous experience of

* 'Report on the Flour Moth.' Issued by the Ontario Department of Agriculture, October, 1889.

† 'Transactions of the Entomological Society,' pt. iv. December, 1887, p. lii.

the great serviceableness of turning on hot steam as a means of clearing out maggots from factories) that by means of hose attached to the engines currents of hot steam should be directed to every part that could be reached. This was on the first appearance of the attack as a mill-pest here.

This plan was carefully carried out; the mill was stopped working for a week, and after blowing the steam, which took two or three days, the men were set to wash the walls (where it could be done without risk of affecting the taste of the flour) with paraffin, and the insides of the machines were washed with a strong solution of soda and water. This solution was mentioned as being very effectual in destroying such of the maggots as it reached. These costly and troublesome measures did much good temporarily, but were by no means a permanent cure.

On the first observation of this very serious infestation in Canada, attempts were made to clear the mills by stopping work again and again, and cleaning down as carefully as possible, but totally without any benefit. It is especially mentioned that they took the clothing from the bolting-reels and cleaned it, and washed the inside thoroughly with soft lye-soap and lime, and did the same with the elevators. "When we started up again every corner and part of the mill had been thoroughly cleaned as we supposed, and we commenced to work again; but after about four days we found our bolting-reels, elevators, &c., worse than before. This went on till the case was considered hopeless, without more stringent measures, and the machinery was taken down and subjected to thorough steaming. Also the mill was swept down and subjected to sulphur-fumes. The walls, ceilings, &c., were cleaned, and elevator-spouts and loose wooden work burnt up. Paper bags and hundreds of dollars' worth of goods were burnt in the furnace; while the other bags, elevator-belts and cups were boiled for hours in a cauldron of water. The machines and parts that were not destroyed were then burnt by means of a kerosene torch, which flamed and smoked through and around every part of them, until we considered we had everything clean and ready for putting together again."

These arrangements, however, were not considered sufficiently stringent to meet the great emergency, and under an order in Council, approved by His Honour the Lieutenant-Governor, further measures to allow of more powerful application of steam pressure for purification of the machinery were carried out as follows:—

"We at once constructed a tight steam-box, 6 ft. wide, 6 ft. high, and 12 ft. long, and attached a steam-pipe to it from the boiler. In this box we put every machine, and even our mill-stones and iron rollers. This process was very expensive, and took considerable time,

as we were over a week at the process, and were delayed in the placing of our machinery. The Board of Health visited us in a body during the time this process was going on, and pronounced it a success. This was all done not only in our own interests, as was pointed out in a letter of the 20th September from Dr. Bryce, but in the interests of the public health and commerce of the country.

“ Having now got to the position which enables us to go to work again after two months' loss of time, and the loss of machinery, fixtures, stock, and expense, we have arranged for remedial measures to prevent the reappearance, or destruction of the pest should we ever be again attacked. We have erected a steam standpipe, with hose or other connection, on each flat of the mill-building. By shutting up all doors and windows of each flat and turning on steam simultaneously to each floor, the whole building can be filled with hot live steam sufficient to kill anything. This will rust all bright parts of the machinery, but to remedy this we intend using oil on them should we ever be under the necessity of resorting to the measure.

“ Another purpose of this steam standpipe will be, in cold weather, to let on sufficient steam to moisten everything, and part of the building at night, and then throw open the windows for the night, and let the frost penetrate so as to kill any eggs or insects that may have become lodged in unseen parts.

“ By these measures, with plenty of light, thorough cleanliness, a cold mill, and caution in taking in stock and old bags, we hope to keep free of a pest which has given us so much trouble and loss.”*

Fumigation and Cautions to be observed.—The use of sulphur and other kinds of fumes may be turned to very good account in lessening the amount of infestation, at least for the time being; but it should be borne in mind that these fumigations must be given with careful consideration as to amount used in given space, or, where the mills are also used as stores, much injury may be caused to the flour standing in sacks.

On this subject I was favoured, on the 8th of June, with the following letter from the owner of some large steam mills which were badly infested:—

“ During the months of April and May, we have on several occasions fumigated the mill with sulphur, as recommended in your Report for 1888, on each occasion being more or less successful in destroying the moths, which have during this warm weather especially infested the place. We started first of all with one fire in the bottom of the

* Report previously referred to, being ‘Bulletin I. of Provincial Board of Health of Ontario. The Flour Moth, *Ephestia kühniella*.’ Issued by the Ontario Department of Agriculture.

building, and burnt about 28 lbs. of sulphur. This quantity we found did not have very much effect, and we from time to time increased the amount, till at Whitsuntide, on the Saturday, Sunday, and Monday, we burnt in two fires about 500 lbs. of sulphur, and thus did good execution; but yet some live ones were found on the Tuesday morning, when the man went round to sweep up the dead ones. We thought these must have hatched out the night before perhaps, and so not have had the benefit of the three days' fumigating.

"But we found that the sulphuring has an effect which we did not anticipate or wish for. We had standing in the mill itself, when the fumigation was carried out, some 80 or 100 sacks of flour, and we find to our dismay that the sulphur has penetrated right into these, and acted on the gluten of the flour in such a manner as to apparently break it up into soluble albuminoids, and render the dough made from it more like a lot of weak putty than the 'strong' tough dough our customers require.

"After noticing this change in the flour we tried exposing a small quantity to the fumes of burning sulphur in a small room, and found the result was the same.

"The effect would be very disastrous to millers who store their flour in the same building as they manufacture it in, as some do; and in our case it has given a lot of trouble. I think you will be glad to know of this, that you may warn your correspondents against sulphuring any building containing large quantities of corn."

I most particularly beg to draw the attention of all troubled with this infestation to the importance of the above observation, and, having given this necessary caution, which I owe to the courtesy of a large steam-mill firm, I extract from the Canadian Government Report, before referred to, some of the methods advised for applying fumigation, and also the strengths specified:--

"To destroy the moths. This can be done by closing the windows, doors, or other apertures of the building, and night after night, until all evidences of moths have disappeared; burn sulphur by placing it in shallow pans upon a number of heated stoves, say small coal-oil stoves, in different parts of the building, and putting a match to it." The note below describes another convenient method of creating sulphur dioxide fumes.

Note.--"To prepare sulphur fumes. Place a metallic dish containing hot ashes on some support in a pan of water, or place in an old pan or other vessel a bed of ashes at least 6 in. deep and about 15 in. in diameter, and place the sulphur and saltpetre in a slight depression in the centre and ignite.

"The proper proportions are 3 lbs. of sulphur and 3 ozs. of saltpetre per 1000 cubic feet of air space. All doors, windows, and other

openings should be tightly closed before the sulphur and saltpetre are ignited."—Page 12 of Canadian Report.

"Chlorine fumes may be used with equal benefit under those conditions where burning sulphur may create an added element of danger from fire."

Note.—"To prepare chlorine fumes. Mix in a glazed dish and place on a stove or other heating surface peroxide of manganese 1 part, sulphuric acid 2, chloride of sodium 3, water 2; or, more easily, by mixing 3 lbs. of chloride of lime and 3 lbs. of hydrochloric acid for every 1000 feet of space."—Page 14 of above Report.

"In burning the sulphur we find the best method is to get old tarred string, such as used for tying up the sacks; put this in a large iron tray and light it before adding the sulphur. The addition of paraffin is also a help, but is, of course, not safe in all places. When well alight add the sulphur. We tried charcoal, but could not get on with it, or shavings."—Communication sent me from infested English steam mills, June 8th, 1890.

General Measures of Prevention.—This infestation may be transmitted with the utmost ease by caterpillars being sent out in flour, or by eggs on sacks. Besides all the troubles that occur in mills and stores, where these caterpillars establish themselves, I am aware of infestation occurring in the neighbourhood, to the great perplexity of all but those who knew whence the pests came.

For this reason it is of the utmost importance that those who wish to keep clear of infection should keep a watchful eye on flour and returned sacks, and, if they have a doubt as to attack being present, then gain a trustworthy opinion as to the nature of what they find.

In the Canadian directions for treatment, it is noted that all bags which have been used for transporting grain, flour, or meal, and which from causes specified are liable to suspicion, should be subjected to thorough boiling, or to superheated steam. The best method to disinfect the sacks or bags may be safely left to millers, but some treatment of exposure to dry or wet heat is certainly needed (where infestation is about) to destroy caterpillars that may have remained inside or outside the bags, or eggs which the moths will have been exceedingly likely to lay outside the meal or flour sacks. These precautions are needed for home use; it is quite too late now to hope to be able to keep the infestation out of the country.

The following general directions (or rather summary of directions) for action on the very first appearance of the moth, and for remedial measures to be brought to bear on infested apparatus, are taken from the Canadian Report before quoted:—"Have the first moths appearing destroyed by hand, and by subjecting the affected portions of a mill or building to repeated treatment with the fumes of burning sulphur

every night when the works stop. If this be persistently followed out but little development of new forms will take place. It must be remembered that this work must be persistent and thorough; abundance of sulphur burnt, again and again, being the sufficient condition of success.

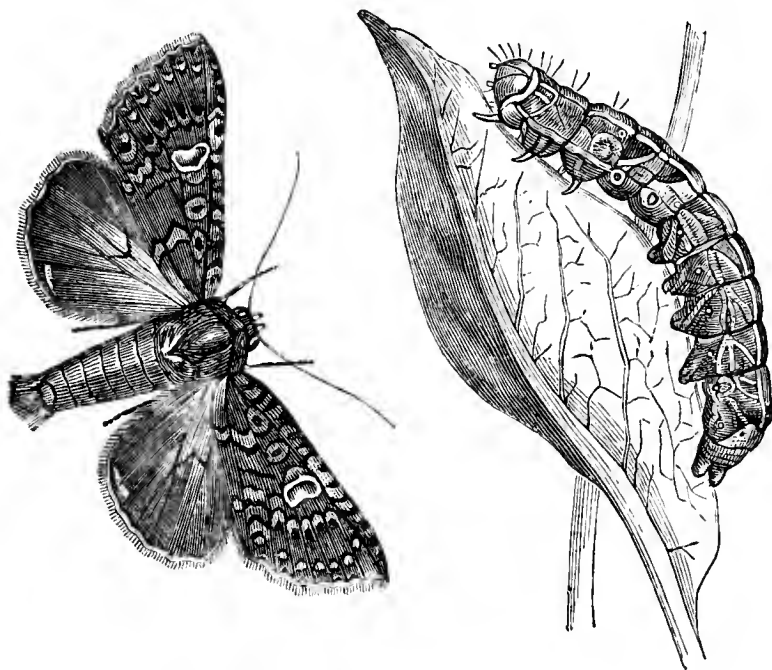
“Where, however, the larvæ have, as it were, gained possession of bolting-cloths and carriers, treatment with steam under pressure driven throughout all parts of the bolting-cloths, carriers, and other machinery has been found very useful in lessening the inconvenience from the spinning of webs, and thereby the clogging of the machinery. The walls, floors, and ceilings may further be treated with advantage by first brushing down all dust, and thereafter spraying them with a solution consisting of a drachm of corrosive sublimate to each gallon of water by means of a gardener's force-pump. Treatment with fumes from burning sulphur while parts are yet moist from this washing down will greatly aid in the destruction of any larvæ or cocoon forms which may be reached.”

Instead of corrosive sublimate a wash formed of soft-soap, water, and paraffin may be used, and applied by a gardener's force-pump. There is considerable difficulty in making the mineral oil and soap wash unite permanently, but if, instead of a force-pump, a large pail was used and the mixture distributed by hand with a syringe, this difficulty would be got over, for the ingredients in the pail would be, or could be, perpetually remixed by repeated action of the syringe. A proportion of 2 gallons of kerosine (or paraffin), 1 gallon of water, and $\frac{1}{2}$ lb. soap, either common or whale-oil or soft-soap, when *properly* churned by a force-pump and spray-nozzle for five or ten minutes, makes a kind of cream. This should be diluted for use at the rate of 1 gallon of the emulsion to 9 of water.

In the foregoing paper I have repeated some small proportion of information from my previous Reports, and given the most important points of the treatment which has proved serviceable at home, and was adopted and much amplified in detail and improved in application in Canada. At present the very seriousness of the infestation is, I know, causing its increase, for no firm suffering under the trouble is willing to let the trouble be made public. But this at least I may say: I have carefully preserved the confidence reposed in me hitherto, and if in the future any firm will be so very kind as to place in my hands any information of measures which are more effective than the partially successful and costly arrangements which, so far as I know, are all that have been tried at present, I would very thankfully make this information public, with the utmost care (unless permitted otherwise) to give no clue to the name or locality of the contributors.

GOOSEBERRY.

Dot Moth. *Mamestra persicariæ*, Linn.



MAMESTRA PERSICARIÆ.

Dot Moth (from life); caterpillar (after figure of Dr. Taschenberg's).

The *Mamestra persicariæ*, or Dot Moth, is very common and widely distributed in England, as well as in various parts of the Continent (notably Germany and Holland); but, although the caterpillar is a very general feeder, as well as very common, it was not until the past season that observations were sent to me of its workings.

On Sept. 27th, I received specimens of the caterpillar, accompanied by inquiries as to the nature of the attack and means of prevention, from correspondents at Leicester. They mentioned:—“We have discovered an unusual visitor at this time of the year in Gooseberry and Currant bushes, as a very active and destructive caterpillar (of different shape and colour), which divests the bushes of all their leaves.”

The specimens gave good examples of the marked variety of colouring which sometimes occurs in the case of this kind of caterpillar. One was rosy brown with brown markings, the other was rather smaller and of a green ground colour.

The figure above gives a good idea of the shape and markings, and also the size when fully grown, of these caterpillars. The head is pale, and sometimes partially withdrawn into the next segment, which has a dark patch on the back, divided lengthways down the middle, and also bordered on each side by a white line, and a pale white line runs down the back. On each side of this line, beginning at the 4th segment from the head and continuing to the 11th inclusive, is an

oblique darkish mark on each side of each segment; these slant backwards so that the pair meeting at the centre of the back form a series of V-like markings, with the point of the V directed backwards. The foremost pair of these markings, as shown in the figure, are the darkest. Beneath these oblique marks is a wavy stripe running along the side, and beneath this again are five oblique bands (slanting in the opposite direction to the uppermost row), of which four run down the sucker-legs. The length, when full-grown, is an inch and a half or rather more. It is to be found in summer and autumn, and when full-fed, which may be towards the end of September, buries itself in the ground to go through its changes.

On Sept. 30th I was favoured with the following notes of observation of attack by Mr. Oliver E. Janson, F.E.S., of Perth Road, London, N.;— “The larva of *M. persicariæ* has been exceedingly abundant and destructive to the leafage of various plants, including Gooseberry, in my own garden this year; there are still many left, although I have destroyed a great number. The variation of colour is very striking, especially the extremes you mention (rosy brown and a beautiful green).”

To this, later on, Mr. Janson added the following note, which is of practical interest, as showing the very great number of caterpillars present, the variety of plants they attacked, and also their great variety of colour:—

“Although I believe insects generally have been remarkably scarce this year, the caterpillars of some of the Lepidoptera have certainly been exceptions, for, besides an unusual quantity of *Pieris rapæ*, *Spilosoma lubricipeda*, *Abraxas grossulariata*, and *Mamestra brassicæ*,* the gardens in this neighbourhood have suffered severely from the ravages of the caterpillar of the common ‘Dot’ Moth (*Mamestra persicariæ*), which made its appearance in extraordinary abundance about the middle of August, and lasted up to the end of September.

“In my own garden, although I destroyed some hundreds of them, their numbers seemed in no way diminished, and almost all plants were attacked by them; but Lettuce, Parsley, Mint, Gooseberry, Geranium, and Marigold they appeared particularly partial to and entirely devoured, and some, which were kept in confinement in a larva-cage, I found would feed as readily on Apple and Poplar as any other kind of plant. The colour of these caterpillars varies very much, and when full-grown some of the varieties are so beautiful that one almost feels reluctant to destroy them; the peculiar shading of the markings of various tints of green, grey, or brown render them

* Popularly the Small White Cabbage Butterfly, Buff Ermine Moth, Magpie or Currant Moth, and Cabbage Moth.

very difficult to detect when at rest in the daytime on the stems or leaves of the plants." This point is important economically, and so is that of their sudden disappearance. On the 2nd of October my correspondent at Leicester above mentioned wrote that the large caterpillars on the Gooseberry bushes had "vanished as if by magic." But they are only buried, and from the dark brown chrysalids beneath the surface the Dot Moths will make their appearance (unless measures are taken to the contrary) about the end of June, or possibly earlier, next year and start new attack.

The moth is of the size figured (p. 61). The fore wings of a rich dark brown or black ground colour, varied with chestnut or rust colour, and small pale spots or flecks at the tips and near the hinder edge, and also bear a conspicuous bright white patch or "dot" (of the shape figured near the centre), from which the moth takes its name. The hinder wings have the lower half pale with a broad dark smoky band towards the margin, and the nervures very observable.

The caterpillar feeds on many kinds of plants, especially on Elder. Amongst field-crop plants it is to be found at times on Mangolds and Hops. It preys on Raspberry, and is noticed by Dr. E. L. Taschenberg as also, in the year 1871, being found on orchard trees. From the lists of its food plants given in different publications and by different observers it is obviously a very general feeder, and amongst the weed plants that it infests is "Knot Grass" from one kind of which the moth takes its specific scientific name.

PREVENTION AND REMEDIES.—No better plan than hand-picking seems to be known of for getting rid of the caterpillars from off the plants. Recurrence of attack in the following year from presence of chrysalids in the ground during the winter may be prevented or much lessened by stirring the soil so as to turn them up to the surface. The exposure to weather, especially to alternate frost and wet when not in their naturally arranged shelters, may be expected to kill at least a large proportion of them. Removal of the weeds which the caterpillars especially prefer for food would also be likely to be beneficial.

Syringings and dusting which would make the leafage unattractive to the caterpillars could not fail to do good. Probably soft-soap and sulphur washes such as Burford's compound, mentioned at page 3, would be useful. Or spraying the infested bushes lightly, so as just to damp the surface, and then dusting well with soot, or with a mixture of soot together with quick-lime, gas-lime and sulphur all very finely powdered together, would do good; or this might be applied when the dew is on.

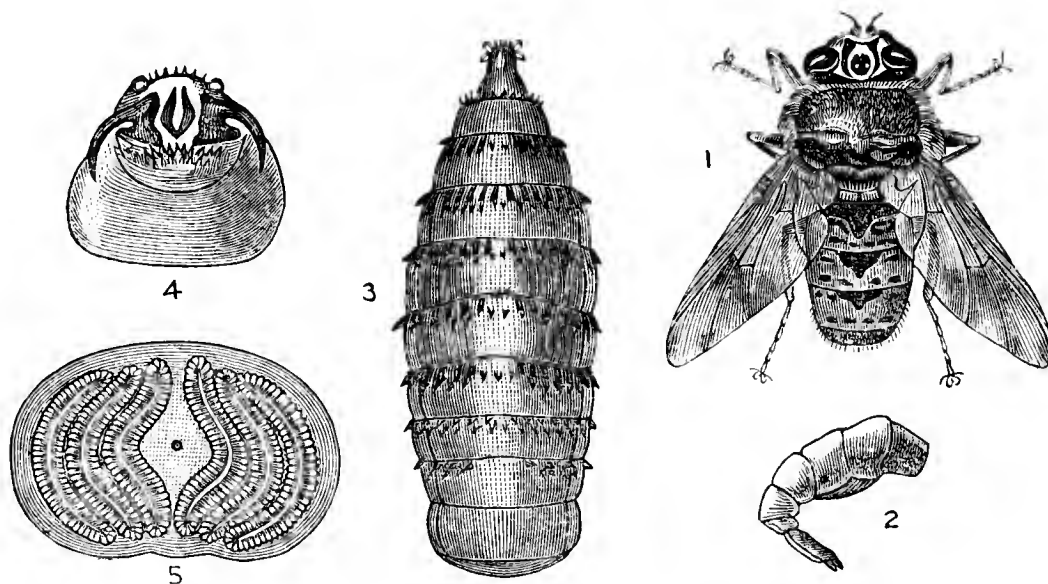
In cases like this a thorough good drenching of cold water may very likely do all that is needed. If the caterpillars fall off with the shock, they

can be killed by being trampled on, and there is also a good chance that the cold water (with them, as with some other moth caterpillars) would bring on such violent purging that they would very soon be reduced to mere skins.

It would at least be worth while to try some of these regular methods of dealing with caterpillar attack, as little appears to be recorded regarding preventive treatment of this special kind.

HORSE.

Horse Bot Fly; Horse Bee. *Gastrophilus equi*, Fab.



GASTROPHILUS EQUI.

1, Horse Bot Fly, male; 2, curved extremity of abdomen of female; 3, maggot; 4, mouth hooks; 5, spiracles at extremity of tail of maggot, all greatly magnified after Brauer, nat. size given in descriptions.

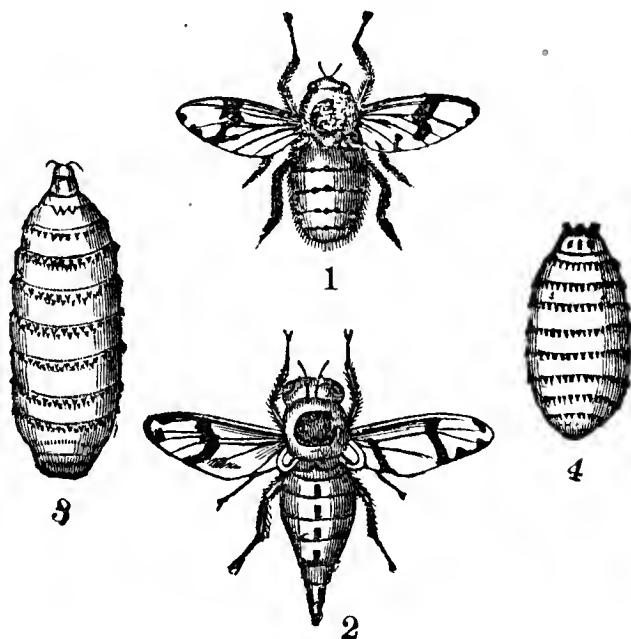
The history of Horse Bot Fly attack has been well known for many years, probably there are few insects of which the habits have been known correctly for so long a time, but still this knowledge is not nearly so widely spread as is desirable, and enquiries as to the nature of the attack, and amount of mischief to be feared from it, are sent me regularly year by year.

I have therefore, according to desire, now given (just for use of those who have not the standard works on the subject at hand) a short description of this infestation, partly from my own observations of the specimens forwarded, which have given me the opportunity of seeing this Bot Fly (or "Horse Bee," as it is sometimes called) in all its stages, as well as the manner in which in bad cases the larvæ fairly coat, or pavement over, the infested part of the stomach, and partly

from descriptions by Bracy Clark,* and German entomological writers up to date.

With regard to some of the internal characteristics of the infestation, I am able to give some amount of reply to the enquiries most frequently made, by extracts precisely bearing on these points from a paper by Mr. D. Hutcheon, C.V.S., Government Veterinary Surgeon, Cape Colony, and also by some observations placed in my hands by Mr. Hy. Thompson, M.R.C.V.S., Aspatria, Cumberland, who has also favoured me by the important assistance of revising this paper before publication.

This attack is widely distributed. It is found all over Europe, in widely separated parts of Africa, notably at Cairo and the Cape of Good Hope, and also in Asia and North America.



Horse Bot Fly, 1, male ; 2, female ; 3, maggot ; 4, chrysalis, nat. size, after Bracy Clark.

The flies are from half an inch to two-thirds of an inch in length. The male with the end of the abdomen blunt, the female with it prolonged, as shown in the accompanying figures, and also at p. 64, where a side view of the ovipositor as curved under the body and much magnified, is given. The colour may be generally described as yellowish brown with black or dark markings (as shown in the figures) on the body, between the wings and down the abdomen. The somewhat shaggy hair is very various in colour, being black or brown or yellowish or whitish, so as to make it difficult to describe the colouring clearly ; in the specimen before me it is much varied with chestnut or foxy colour on the abdomen.† The long ovipositor of the female is of a shining black brown.

* Essay "On the Bots of Horses and other Animals," by Bracy Clark, F.L.S.

† For minute description of colours and details, see 'Monographie der Œstriden,' von Friedrich Braner, pp. 69—71, and also, for the above and life-history, 'Praktische Insekten Kunde,' by Dr. E. L. Taschenberg, pt. iv., pp. 73—76.

The two wings are moderately large, closed together when at rest, hyaline, sometimes opaque white; with a transverse brown or grey band and two spots, or a slight marking at the tip. The legs are long in proportion, smooth and mostly yellowish brown. The fly is known by the various names of the Great Spotted "Horse Bot Fly"; the "Horse Bee"; and also, from one of the places it selects for egg-laying, as the "Knee Bot Fly."

In Europe the fly is to be found from June or July until October. It is of some interest to note that, in the observations of the veterinary surgeon of Cape Colony, the time of the deposit of the eggs varies from what it is here correspondingly with the different time of year of the summer season in that part of the world. He found egg-laying to begin about the beginning of January, and to continue until about the end of April.

The eggs are hardly the twelfth of an inch long, white, spindle-shaped at one end, and obliquely truncate at the other, and are attached by the female Bot Fly to the hairs of the Horse. The hair of the mane, the shoulders, and the inside of the knee, are places especially chosen for egg-laying.



Eggs of Horse Bot Fly, nat. size and magnified, after Bracy Clark.

The method of deposit is for the fly to poise near the Horse, and then flying at the spot to leave the egg fixed to the hair by a glutinous moisture, and so to continue until four or five hundred eggs may be laid on one animal. Her whole supply is stated to be as much as seven hundred.

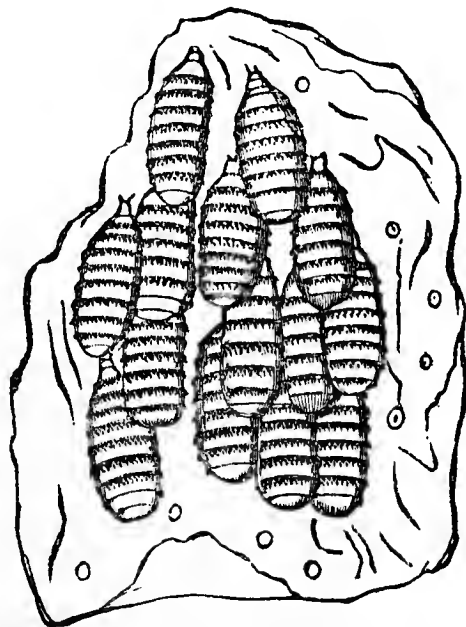
These eggs are ready to hatch in a period variously stated as from about five days to three weeks, but the maggot which then emerges is *not* at first of the shape figured (p. 65), which it gradually grows to, but very much narrower in proportion, more like a short worm, smallest at the tail end and gradually increasing in width till about the fourth ring from the head, or anterior extremity, and then quickly lessening again. How these maggots are conveyed into the Horse does not appear to be an absolutely settled thing; some *may* possibly creep through the hair to the mouth. The most commonly received opinion however, is, as given by Dr. Cobbold and others, that the moisture and warmth from the Horse's tongue when he licks the spots where the eggs are attached hatches them, or, rather, helps to free the maggot if near hatching time, and the maggot being produced adheres to the Horse's tongue. Thus some amount of larvæ from the many eggs laid are conveyed into the mouth whence they pass downwards, or are carried downwards with food, &c., from the mouth to the stomach.

On the above points I was favoured with the following practical

observations by Mr. Hy. Thompson, M.R.C.V.S., of Aspatia :—" I have never seen or known of the small insect after being *hatched* on the legs, shoulder, or sides of the Horse, creep along the body to get into the mouth. The shoulder and inside of the knee and foreleg generally are the places where we find the eggs are most frequently deposited, being naturally the most suitable situations, and, from the heat of the Horse's body, I think the ova are hatched there, causing a tickling sensation in the part which the Horse licks with his tongue, and the small creatures are carried into the stomach with food and the secretion of the mouth."—(H. T.)

There the maggots fix themselves to the mucous membrane by means of two dark brown hooks (see fig. p. 64), one of which is placed on each side of the slit which serves for a mouth, and there they nourish themselves by suction. As they grow older they alter in shape to that figured at p. 65 (and much magnified as at heading, p. 64), and are considered to pass from 8 to 10 months in maggot state, attached by their mouth hooks to the lining membrane of a portion of the stomach.*

Sometimes there may be only a few of these maggots present, sometimes (as I have seen them myself) they are present in such numbers as to lie close up against each other over a large patch of surface, so that it hardly seemed possible to find room for another amongst them.



Maggots or Horse Bots attached to membrane of stomach, after Bracy Clark.

The above figure shows a number of partly grown Bot maggots attached to the membrane of the stomach. By this time they have gained their characteristic form, which is somewhat barrel-shaped, banded round at intervals by lines of prickles or horny points. They are widest about the middle, rather smaller at the tail extremity, in

* For detailed remarks on this characteristic of the attack which is very important, see observations further on.

which are the spiracles or breathing apparatus figured, magnified, at p. 64, and diminishing more quickly towards the anterior extremity, in which are the mouth hooks figured, magnified, also at p. 64.

The maggots are of various shades of flesh colour; when full grown they are yellowish flesh colour and about three-quarters of an inch or rather more in length, and about a third of an inch wide at the widest part.

The time passed in maggot condition is about 9 or 10 months or possibly more. When full grown they loosen the hold of their mouth hooks, by which they have kept themselves in position, and passing along the intestines are discharged from the animal, and fall to the ground with the rejectamenta.

They bury themselves in the Horse dung, or in the ground, and there turn to brown chrysalids (formed outside of the hardened skin of the maggot), from which the fly comes out in about six or seven weeks during summer.

PREVENTION AND REMEDIES.—Combing, brushing, clipping hair at the infested spots, and the use of soaps and washes, which would not be in any way injurious to the Horse, whilst they would help to clean off eggs and hatching maggots, are amongst the regular methods of treatment. Any safe wash or smear with strong carbolic or mineral oil smell, or any other scent obnoxious to the flies would of course be a deterrent of attack. Also (looking at how strongly the point is brought forward that the united *warmth* and *moisture* of the Horse's tongue promotes hatching out of the maggots), warm washings which open the eggs, and clear or kill these maggots as they hatch, might be expected to be of use.

If the flies as a rule do not follow the Horses into stables, it would of course be of some preventive service where animals were out at grass (and it was desired to preserve them from attack) to have sheds into which they could go in the heat of the day, when annoyed by fly attack.

Also, where the yellowish pink maggots, or brown chrysalids which are much like them in shape, are in such numbers as to be noticeable in the Horse droppings, it might be desirable to attend to this matter in any way which would most conveniently destroy the infestation.

With regard to season of attack and some methods of treatment, Mr. Thompson remarked:—"Haytime (July and August) is the time most noted in the north for observing the ova deposited on the Horse; there is no rubbing them off. They are firmly fixed—glued to the hair. To prevent development, Horses at work could have the ova scraped off and the parts rubbed with turpentine, and animals at grass could be brought in once a fortnight, examined and treated in the same way."—(H. T.)

Some of the points especially brought forward for notice in

enquiries are the amount of injury supposed to be shown by the state of the membrane from which the maggots have been removed, and also the idea that a great hole or perforation has been caused by the maggot attack. As these points are not what I could give an accurate opinion on, I have never offered any observations on them to correspondents beyond recommending application for proper veterinary advice, but during the past season the following observations given on these points, by Mr. D. Hutcheon, C.V.S., Government Veterinary Surgeon, Cape Colony, reply so clearly and precisely to these enquiries that I give them (duly acknowledged), followed by the observations with which I have been favoured by Mr. Hy. Thompson, M.R.C.V.S., of Aspatia.

The following observations are from the 'Agricultural Journal,' published by the Department of Agriculture of Cape Colony, No. 34, pp. 278, 279.

The situation of the Bots in the Horse's stomach.—"A great deal of misunderstanding, with reference to the injury which the Bots inflict upon a Horse's stomach, arises from the fact that few non-professional men are acquainted with the normal appearance which it presents. When a Horse's stomach is opened, one is at once struck by the different appearances presented by its internal membrane according as it is examined to the right or left. To the left, where the gullet enters, the lining membrane has a pale white appearance, and is firm and resisting to the touch. This white and resisting lining terminates in the centre of the stomach by a distinct wavy ridge. Beyond this ridge on the right side, which terminates in the opening to the intestines, the lining membrane is of a purplish or reddish brown colour, very vascular and appearing inflamed when compared with the white lining membrane of the left side. It is this division of the mucous membrane lining of the stomach of the Horse into two distinct portions which have led amateur anatomists astray.

"I have observed this peculiarity at every *post-mortem* examination of a Horse which I have made in the Colony.

"On cutting open a stomach, emptying and cleaning it, so as to exhibit its general appearance and the position which the Bots occupy, it is very rare that some one amongst the by-standers does not call out, 'There you are! Don't you see the Bots have eaten off half of the lining of the stomach!' They observe the Bots sticking in a close cluster on the white membrane which lines the left or gullet-end of the stomach, and on comparing this part of the stomach to the other end, which terminates in the intestines and has a reddish raw appearance, exactly as if the white lining had been torn off from it, the conclusion arrived at—and a very natural one too—is that the Bots have already eaten off the white lining on the right end of the stomach, and are

about to commence operations of a similiar character on the left.

“ Another source of error is the fact that each Bot pierces a small hole about the size of a pinhead through the white lining of the stomach. If the Bots are pulled off, the part of the lining where they were clustered looks like a sieve. Although I have even seen Bots burrow through between the inner white lining and the muscular layer of the walls of the stomach, when the *post-mortem* examination was delayed for some time, I have never seen any inflammation about these holes, neither have I ever seen the stomach pierced right through as many have asserted. Were any of these large holes made before the animal died, there would be a raw vascular appearance about the edges of these holes which as stated I have never observed, clearly indicating that any piercing, beyond the small pinhead holes which always exist while the Bots are there, took place after the death, when the Bots began to move about.

“ Another error, which I have seen more than one farmer make, is to mistake the hole made by cutting off the œsophagus for a hole pierced by the Bots. This misconception arises from the fact that the Bots are very often clustered immediately around the entrance of the gullet into the stomach. When the stomach is thus cut out as usual, by cutting off the gullet close to the stomach, and the stomach is afterwards opened carelessly, that opening made by cutting off the œsophagus is frequently mistaken for an opening eaten through by Bots, since a few Bots will generally be found on the outside of the hole, and others in the act of passing through it. I have opened very many Horses in this Colony which have been certified to have died from Bots, but I never saw a case in which there was the least evidence that the Bots had anything to do with the animal's death.” *

Further on in the above paper the writer remarks with regard to suggestions, “ whether the presence of the Bot maggots may not seriously interfere with the Horse's digestion by destroying the healthy functions of the membrane to which they are attached ” ? “ the portion of the stomach to which the Bots are attached is lined by a strong white mucous membrane, which contains no gastric glands, but is covered by a thick layer of epithelium which protects it from injury. Bots do not therefore interfere directly with the gastric digestion of the Horse. It is the other end of the stomach which contains the gastric glands and which performs the whole of the digestive process carried on within a Horse's stomach.” †

* “ Diseases of the Horse,” by the Colonial Veterinary Surgeon, ‘Agricultural Journal,’ published by the Dept. of Agriculture, of the Cape Colony, No 34, Dec. 12, 1889.

† Paper on “ Diseases of the Horse,” previously quoted.

The following communication with which I was favoured by Mr. Hy. Thompson, is to the same effect. He observed that the young Bot maggots "are carried into the stomach with food and the secretions of the mouth and deposited on the anterior or cuticular portion of the stomach.

"The stomach of the Horse has two linings, one half is cuticular, the other villous, or true digestive portion. I have seen a large number of cases but never saw the Bots attached to villous portion. Possibly the gastric juice (hydrochloric acid) is too strong, and destroys them in this portion before they become attached? Again, where the Bots are attached, the parts or walls of the stomach are thickened.

"I have never seen the stomach entirely perforated, but the irritation induced by the development of the larva causes in many cases a great wasting of flesh in the Horse.

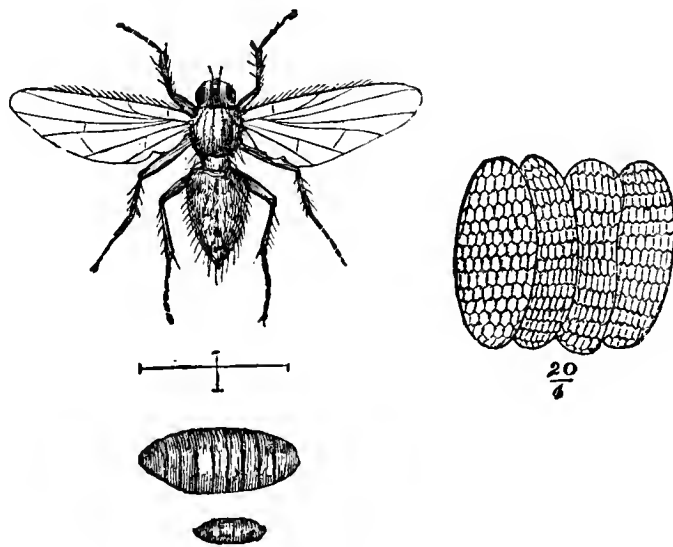
"I know of no medicine that will destroy them, or make them leave their winter quarters until fully developed. A good feed of grass in early spring induces them to detach themselves the soonest, but I am inclined to think the larva will hold on till fully developed before leaving.

"As a medicine, 2 ozs. turpentine and 20 ozs. of raw linseed oil mixed, and given as a draught once a fortnight is the best remedy; *i. e.*, if it is thought the loss of flesh and condition of the Horse is due to the presence of Bots."—(H. T.)

In offering the above paper I have done so with some hesitation, as being quite outside my regular work on *crop* infestations. But some information about this attack has been so much wished for by those who have no opportunity of consulting standard works on the subject, that to the best of my power I have described the life-history of the insect (with which I am necessarily well acquainted). On the internal points so often erroneously thought to show great injury, I have ventured to lay before my readers the opinion of two well known veterinary surgeons. To those who desire further information, I believe I could give any details required, bearing simply on the life-history of the insect itself; the anatomical and veterinary points they would doubtless gain all information on from their veterinary advisers.

MANGOLDS.

Mangold or Beet Fly. *Anthomyia (Chortophila) betæ*, Curtis.



A. betæ (female), mag.; line showing spread of wings, nat. size; pupa, nat. size and magnified. Eggs (after Farsky), mag.

During the past season Mangold-leaf maggot has, as usual, been doing mischief. This, as for the most part is well known, is a small whitish, legless maggot, which feeds between the upper and under sides of the leaf. Thus blister-like patches are formed where the substance of the leaf has been destroyed, and, according to whether these are few or many, so is the amount of injury done. Sometimes (especially when the crop is attacked when young) the greater part of the leafage is destroyed.

The maggots feed for about a month in the leaves, and then turn to chrysalids (usually in the ground to which the maggots have fallen from the leafage above). From these chrysalids the greyish flies soon appear, so that there may be a succession of broods during the summer, and the damage through injury to the Mangold or Beet leaves is at times very great.

The history of this attack, and such measures of prevention and remedy as have appeared serviceable up to date, have been so often given that it is unnecessary to repeat them; but the great difficulty has been to gain knowledge of some kind of dressing that it was possible to apply, and which might be depended on as a beneficial application to the crop when badly injured.

Notes have been given of good effect from applications of guano, also of soot, and of mineral superphosphate, the effect of the superphosphate in this set of parallel experiments being the best.

But the most markedly good results were given by nitrate of soda, sown between the rows just before showers, which answered excellently in bringing Mangolds, of which the leafage had been almost destroyed by the maggot attack, well round, and giving a good crop of roots.

I was also favoured with notes by Mr. Jabez Turner, of Norman Cross, Peterborough, showing the benefit of autumn manuring and working of the ground, thus securing such a good tilth and condition of land at sowing-time as will force the plant on past ordinary fly-attack.

In the past season experiment was made, at Rothamsted, as to effect of application of nitrate of soda to a crop of badly-infested Mangolds. This was attended with such marked success that I requested permission of Sir John B. Lawes to publish a note of it in this Report, and, this permission having been kindly given, I am much gratified to be able to lay before my readers the following valuable detailed observation on serviceable and easy remedial application for this destructive attack :—

“ *Insect Injury, 1890.*—A field of Yellow Globe Mangolds of 14 acres on the farm of Sir J. B. Lawes, at Rothamsted, was badly attacked by the Mangold Maggot (*Anthomyia betæ*).

“ The field was manured with 20 tons per acre of farmyard dung, applied just previous to sowing the seed. The injury commenced in July, and gradually got worse until the leaves of the whole crop had the appearance of being scalded. They were of a brown colour and greatly shrivelled up.

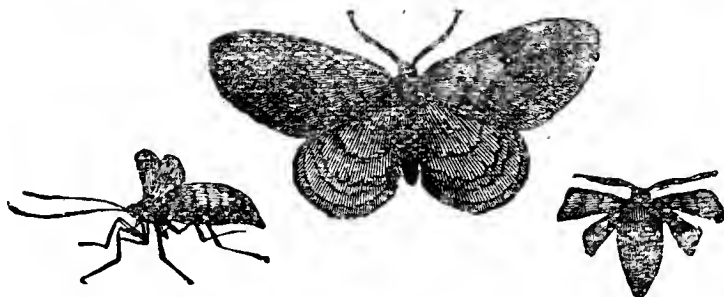
“ In the first week of August an application of 2 cwt. of nitrate of soda per acre was sown broadcast over the whole field. The injured leaves soon died off, and the plants formed new growth.

“ The crop was taken up towards the end of October, and gave an average produce of almost 18 tons of roots to the acre.”—(Communicated by J. J. Willis, with the permission of Sir J. B. Lawes.)

ORCHARD MOTH CATERPILLARS.

Winter Moth, Evesham Moth, *Cheimatobia brumata*, Linn.; March Moth, *Anisopteryx æscularia*, Schiff.; Common Vapourer Moth, *Orgyia antiqua*, Linn.; and other species.

Winter Moth; Evesham Moth. *Cheimatobia brumata*, Linn.



Winter Moth (*Cheimatobia brumata*): male, and wingless females.

The date of first attack of Winter Moth caterpillar in the past season might be put (so far as reported) as being about the end of March. At that time Winter Moth caterpillars were beginning work near Ross (Herefordshire), although they were not then noticeable at Toddington; and I had opportunity myself of seeing them hatching from collections of infested twigs and prunings placed in my hands for special observation.

By means of these specimens I was enabled carefully to study the changes of colour of the egg which occur during its advance to maturity, and also its form and size, and the external markings of the egg-pellicle; and afterwards, in the course of November, I had the further opportunity (from newly-laid specimens) of noting the colour when first deposited. As these points are all of practical use in determining what kind of infestation is present, I give some notes of the observations which I was enabled to make in detail.

On the 11th March I received, from Mr. Jesse Garrood, of Ledbury, cuttings of Apple twigs, which he mentioned he "had placed in a box in the autumn with a number of Winter Moths, male and female, the eggs deposited on the spurs being the eggs of the Winter Moth."

These twigs I placed in a box in my study, and on the morning of March 26th I found that many of the eggs had hatched. The empty shells were now mere iridescent films of whitish or bluish skin, almost glassy in brightness, and to the naked eye giving completely the appearance of the parts of the twigs on which they were placed being beset with little patches of bluish or greyish mould, or the down natural on some Apple twigs.

The eggs are bluntly oval in shape,—or perhaps might be better described as cylindrical, rounded at each end,—about a 32nd of an inch

in length, that is, about one-quarter of an eighth of an inch long; the width about two-thirds of the length. Some of the eggs were still of the pale reddish tint of which they all appeared when sent to me, and a few were of a green tint--this apparently from being near development. The egg skin was pitted over the surface. With the help of a moderate magnifier it had the appearance of being shagreened. Under a one-inch power the markings showed as fairly regular circular depressions, so regular, in fact, as almost to give a honeycomb-like appearance.

The caterpillars were loopers, of a colour that might be described as dingy green or grey, and had black heads. They were perfectly active, moving characteristically in loops, or fixing themselves by their sucker feet and raising themselves erect, as if surveying the surroundings.

Taking now the development of the above eggs (which had been recorded by Mr. Jesse Garrood, of Ledbury, to be the eggs of the Winter Moth, deposited on Apple twigs placed in a box in which he himself had confined male and female Winter Moths in the autumn),—taking this as a guide, I proceeded to examine progress of eggs on trimmings from Pear trees sent to me, on March 12th, by Mr. C. Lee Campbell, of Glewstone Court, near Ross.

This was a very large collection, being the amount of trimmings or cuttings from ends of boughs taken by three men in three hours, in order to give me an idea of the great quantity of coming infestation, which might be removed by pruning in cases where the ends of the bough were in reach. The specimens, which were mostly in little bits, nearly filled a box about 15 in. long by 7 across, and 5 in. deep.

These eggs were somewhat differently placed to those on the Apple twigs. On the Apple twigs they were mostly on the shoots, though some were in the angle between the shoot and branch. On the Pear the eggs were mostly at the end of previously cut-back shoots, where the drying of the wood and swelling over it of the healing bark makes a protective depression. In either case eggs appeared to be deposited in the best shelter afforded.*

Some small part of the specimens sent me by Mr. Lee Campbell I kept in my study (in the same circumstances, that is, as those sent by Mr. Garrood), and at same date I found them hatching similarly. My eye was attracted by the little bright or whitish mould-like spots; and I found similarly empty egg-shells and greenish eggs, and some still reddish. The eggs had similar inequalities in the surface, and the little looper caterpillars were similar in appearance, and were already,

* Figures of the infested shoot (nat. size), also of cut-back shoot with the eggs deposited in a circle at the end (nat. size and magnified 5 diameters), will be found in the number of the 'Journal of Horticulture' for June 5th, 1890, p. 467.

though hardly the sixteenth of an inch in length, dispersing themselves about the inside of their box, and when disturbed were already able to spin a thread to attach themselves by.

On the 28th of November I was favoured, by Mr. B. Danks, of Charlton House, Hartlebury, Kidderminster, with a tar-grease band on paper, about 2 ft. 3 in. long and 6 in. wide, as an example of the method in which the mixture used captured and held fast the moths. On this I found upwards of two hundred Winter Moths (male and female). In some cases the females had expelled a portion of their store of eggs, so that, where they were uninjured, the little knot of minute greenish bodies was very conspicuous on the dark sticky-banding mixture. The eggs were of a pale or watery green colour, pitted over the surface with hexagonal (or irregularly hexagonal) depressions; as nearly as I could count or estimate, there might be about twenty of these little pits or depressions in the length of the egg.

These markings were much more defined in the newly-laid eggs than in those in progress of development, so that the honeycomb-like markings which were irregular in the previously observed eggs showed very plainly in the recently expelled specimens. The colour also was of importance, as this, as well as the surface being punctured, agrees with the description given by Dr. E. L. Taschenberg of newly-deposited eggs of *C. brumata*. In the early spring observations we could only record them in the reddish tints which they gain in advance towards maturity, or in the various shades they assume just before hatching, from the tints of this very variously coloured larva showing through the transparent pellicle.

All the other points in the life-history of the Winter Moth which it is necessary to be acquainted with for practical purposes have, I believe, been brought forward so thoroughly in previous Reports that there is no need to enter on them again here, excepting, perhaps, to notice the continued confirmation given to previous observations of the wingless female being in some cases transported to the trees in connection with the winged male. Of this I have received direct record from observers during the past season, the pair being in one case captured after flight, and arrival in the tree, and preserved in confirmation of the statement. This habit is important to notice practically, and is the reason for our use of lanterns and sticky boards expressly to attract the winged male moths, whose presence otherwise would not require notice.

The March Moth was observed by Mr. C. Lee Campbell, of Glewstone Court, Ross, Herefordshire, as beginning to lay eggs about the middle of March. The specimen sent me on the 15th of March I found on the 18th had laid eggs, using the hairs from the pencil at the end of the tail (as is the custom with this moth) for a covering.

March Moth. *Anisopteryx æscularia*, Schiff.

March Moth ; winged male, wingless female, and band of eggs.

This moth has been little, if at all, reported amongst the regularly recurring orchard pests, although it is a common kind, until last year (1889), when it was observed laying its bands of down-embedded eggs at the end of March (specimens sent me on the 29th) on Plum twigs at the Dimsdale Fruit Farm, Westerham, Kent. The caterpillars are "loopers," and of light or clouded green. If the caterpillar pests that appear in April were carefully examined, probably those of the March Moth would be found to be largely present amongst those commonly classed all together as those of Winter Moth, and their presence be found to be one amongst various reasons why even the most careful sticky-banding in autumn is not a perfect remedy for looper-attack. The female March Moths are distinguishable by being apparently quite wingless, with silky coats, brownish above, shading to grey below, and furnished with a dark pencil of hairs at the end of the tail, with which they cover their bands of eggs.

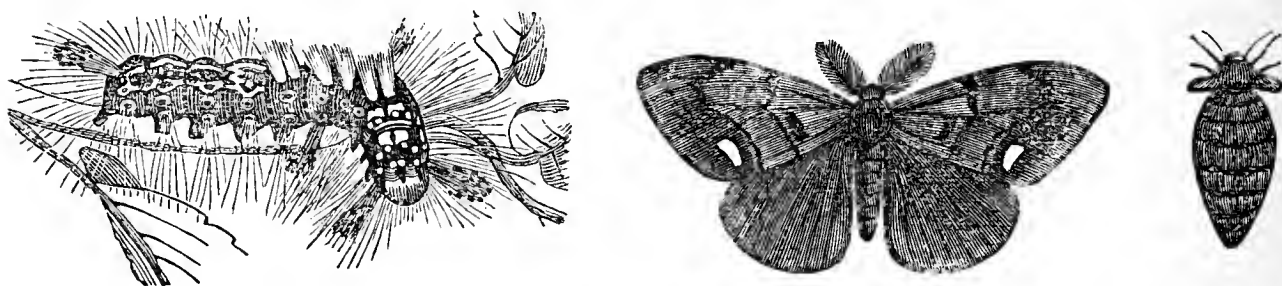
The only available means of prevention for this attack appear to be "sticky-banding" as for Winter Moths, but applied about the middle of March ; also subsequently (about the end of March) looking for the rings of down-covered eggs at the end of small shoots or twigs, and cutting these off, *where in reach*, and destroying them. Also, as the chrysalids are considered to lie in their loose webs during winter, either *on* or in the ground, this is certainly a case in which stirring the surface during winter would be likely to do a great deal of good.*

The ordinary orchard moth attacks have been so fully and frequently entered on before that there is no occasion to repeat the observations. Amongst the most noticeable of them are damage from the brown and yellow "looper" caterpillars of the Mottled Umber Moth. Also from the gaily-striped orange, blue and black, somewhat large hairy caterpillars of the Lackey Moth, and the small greyish or white, or lead-colour (according to age or variety), spotted with black, of the "Small Ermine" or Small Apple Ermine Moths—these kinds being web-nest- or tent-making caterpillars. The large "blue-head" caterpillar of the Figure-of-8 Moth is another orchard pest, easily

* For account at length of appearance and habits of March Moth, see 13th Report on Injurious Insects, by ED.

distinguishable by its large size, being about two inches long when full grown; by its greenish colour above, with a yellow stripe along the back and one on each side; by its yellow-green colour below; and by its black spots; also, frequently, from the bluish tint of its head, from which the caterpillar takes its name. Figures and descriptions of these have been given in previous Reports.

There is, however, another kind of caterpillar, that of the Common Vapourer Moth, *Orgyia antiqua* scientifically, which has a capacity for doing excessive damage to leafage, but also (from the peculiarity of its habits) may be easily kept in check on moderate-sized trees. The male moth is of the size figured, the body and head brown, wings chestnut-brown, the fore wings patterned with darker bands, and with a white somewhat kidney-shaped mark on each. The female is grey, and almost wingless, and does not quit the immediate neighbourhood of the web-cocoon, from the chrysalis within which she has developed.



ORGYIA ANTIQUA.

Caterpillar (after Taschenberg); male moth; female moth, with abortive wings.

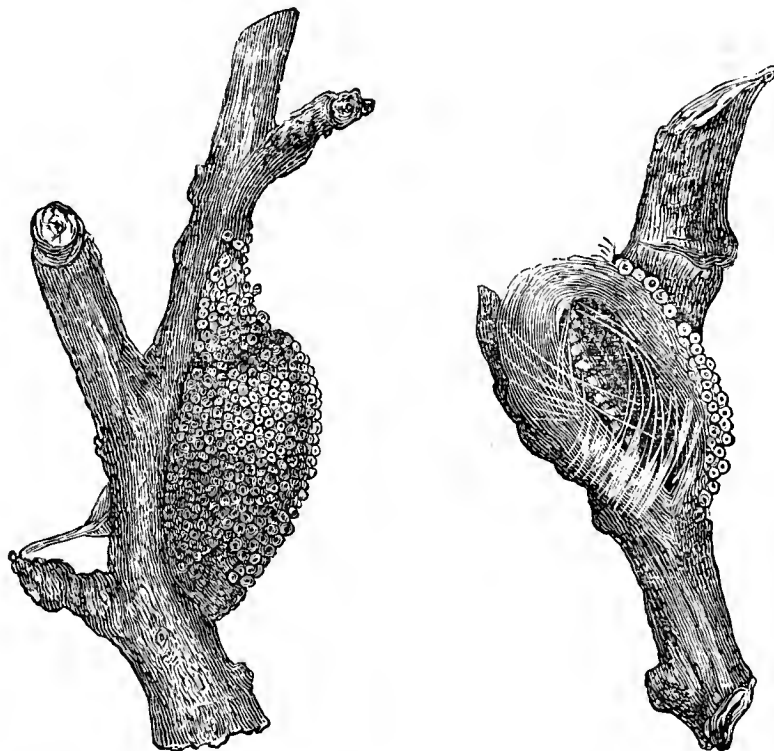
The life-history is for the female when she comes out from the chrysalis to creep to the outside of the web-cocoon; their pairing takes place, and very soon after she begins to deposit her eggs on the cocoon, and near it, and dies. The accompanying figures, drawn from life, show the cocoon covered with eggs, and also a cocoon torn partly open to show the brownish or dusky yellow chrysalis lying within.

These fine caterpillars, which are stated to vary in length from about an inch and a quarter to two inches, when full grown, are dark grey, spotted with small red tubercles, and easily distinguishable by having four large tufts of yellowish or brownish hairs on the back, and also five pencils or bunches of long, dark, pin-headed hairs, disposed—one on each side behind the head, pointing forwards; one on each side of the fifth segment; and one on the back of the penultimate segment, forming a sort of tail-like appendage. By these characteristics the caterpillars are easily known from shortly after hatching. They appear to feed on almost all kinds of leafage, not only of orchard trees, but of Hawthorn, Sloe, and of Roses and other garden plants.

When full-fed, which may be from May to August, they spin their cocoons mixed with hairs on the twigs amongst the remains of the leaves on which they have been feeding, or on trunks of trees or

palings, and in these the caterpillar changes to chrysalis, from which the moth appears in summer in about a fortnight. It is noticed by Edw. Newman, in his 'British Moths,' p. 40, that:—"The eggs do not hatch together like those of moths in general, but come out a few at a time over a period of ten weeks, so that the caterpillar, chrysalis, and moths are all found together throughout the summer and autumn."

In 1886 caterpillars were sent me on July 22nd from Linton-on-Ouse, with a report that two fruit trees had been stripped bare of leafage through the ravages of the caterpillars, and that they might be counted by thousands in all parts of the garden, and that this had been the case for four years, but that none of the neighbouring gardens were touched. In the same year I had a note of them as injuring Pear trees in another locality, and as having destroyed the leaves of most of the trees in that same locality in the previous summer.



Cocoons of *O. antiqua*, respectively covered with eggs, and showing chrysalis within.

Excepting, however, these observations, I am not aware of any notes of its presence having been sent until the past season, in which I had an observation in the early part of July of the caterpillars doing great damage to Plum (especially to Victoria and Greengage) in an orchard house in some well-known nurseries in the South of Ireland, where it was noted as being "most destructive if neglected."

The real trouble from its presence, however, is where it gets hold in regular orchard growths, and relatively to this point I was favoured in November last with excellent specimens of the egg-covered web-cocoons, and also an opened web showing the chrysalis skin still remaining within, which were sent to me from Croome Court, Severn Stoke, Worcestershire, by direction of the Earl of Coventry.

By kind permission of Lord Coventry I give the above figures of two of these specimens, and the short note of observation following:—

“My bailiff yesterday, in looking round the trees, detected amongst the branches eggs on a web, and the deposits which he supposes are also eggs.” My attention was also directed to the remains inside the cocoon, which proved to be the chrysalis.

Examination of the figure will show the great number of eggs quite coating over the outside of the cocoon, and consequently show that the starting point of what would be much future mischief if neglected, may be very easily got rid of where the egg-covered cocoons are in reach. These should be carefully looked for, cut off, and destroyed wherever infestation is found to be present. When the twigs are out of reach of common measures, the use of a pair of very small, sharp hawks'-bill nippers, placed at the end of long-handled shears, would be desirable.

So far as I am aware, this kind of implement is not nearly as much used as it should be. I have myself found a form with light handles about five feet long extremely convenient, and by means of a light hand-cart, which could be easily wheeled from tree to tree, a moveable platform would be available by which the operator could reach to a very fair height. A plank laid across the little cart from side to side would give firm standing position, and a means of reaching up to egg-laden twigs of many kinds,—notably of Winter Moth and Mottled Umber, and the egg-bands of the Lackey and Vapourer,—and (generally) give, with moderate convenience and little expense, a means of carrying clearance of pest presence about five feet higher than is often the case.

PREVENTION AND REMEDIES. — The careful series of observations which, either in experiment or regular practice or report of results, have been continued from February last up to this present date of December, 1890, show that the two main points to rest on for prevention and remedy of loss from attacks of orchard moth caterpillars generally are—“sticky-banding,” to stop the ascent of the wingless moths; and spraying, to destroy the hordes of moth caterpillars of any, and all, of the various kinds which ravage together on the leafage in spring.

The reader will please observe that here we are only speaking of MOTH CATERPILLARS, not of Aphides or Green Fly, nor of Beetles, nor of Scale or other kinds of insects, which, being in some cases stationary, in some reaching their position by flight, and in some gaining their sustenance by driving their suckers into the soft tissues from which they draw the juices,—thus are not captured by “sticky-bands,” as they have no occasion to cross them; nor are they destroyed by poisonous spraying on the leafage, for their suckers go down beyond the excessively slight superficial coating which alone is to be recommended for special use.

With regard to sticky-banding.—The great points are to use a grease or preparation which will continue sticky, but not be moist enough to run down, and also (and this point is of *vital importance*) so to apply it as not to injure the bark and underlying tissues of the tree. The safest plan is to band on strips of common strong grease-proof paper. This can easily be procured at a small cost, and cut in strips of about seven inches wide, or of whatever width may be wished. The length may vary or not with the size of the tree, for there is no harm in the ends of the strip overlying each other. The method of application is for the strip to be placed round the tree, and fixed firmly either by being tied securely with string passed round near the upper and also the lower edge, or by running a band of paste beneath the overlapping end of the paper, and thus keeping it fixed safely down on the rest of the paper. On this strip the grease may be painted, or it may be smeared on with a smooth bit of wood like a paper knife, and thus all or much of the risk of grease soaking into the bark be avoided.

How far yearly application, even of good grease, may affect tender bark and underlying tissues, is a point which can only be known by examination, and which it would be well to have further notes of. In a letter to myself Mr. J. Masters mentioned the difficulty of getting pure grease, and that, if not good, sooner or later it would be found to affect the trees. “Some of the fruit stems I have felled, in cleaving them up, show distinctly, as compared with the other parts of the tree, how the grease has penetrated the inner coatings of the bark.”—(J.M.) I should fear that this would be the case oftener than is supposed, even with good grease.—ED.

Tar should *never* be applied to the bark. The late Capt. Corbett, Manager of the Toddington Fruit Grounds, wrote me:—“Please note I have discarded tar, for I have found instances where even when mixed with grease it has on drying formed a tight band round the bark and destroyed the tree.”

Mr. C. D. Wise also wrote from Toddington:—“Where tar has been used I have found the tree alive up to the place where the band was put on, but above the band dead.”

Judging from a specimen of tar-grease banding now before me, I should say that even for use on grease-proof paper an admixture of tar is not safe. The mixture has been very successful in catching the male and female moths, but at the date of examination (Dec. 10th), that is, a few days after it was sent me, I find that the back of the long strip of “grease-proof” paper is of a deep brown from the tar, or tar and grease together, having soddened through from the front. The extent of the mischief in a case like this would be nothing to compare with that of tar banding on the bark itself, because, amongst other reasons, the application itself is not left to form a crust on the bark,

gradually melting into it with warm sunshine ; but still, considering the variety in the composition of mixtures used for grease, or sticky-banding, it would be as well to be sure that the kind of grease-proof paper used would not allow them to penetrate to the bark.

The mixtures sold under the name of cart or waggon grease, or as axle grease or railway grease, differ exceedingly in the ingredients used, and in some cases might be exceedingly hurtful. The simplest form for what is sold as cart grease appears to be a mixture of tallow, palm oil, and soft-soap. Another mixture is of a more or less perfectly formed soap, water, carbonate of soda, and neutral fat. Another is a soap of lime and rosin oil, with or without water ; and a mixture similar to this last or much resembling it was found to answer well at Toddington. A grease with tar oils mixed with sulphate of lime and water burnt the bark, and this is just an instance of where grease-proof paper would need testing. If it resisted the penetration the additional deterrent powers of the tar oils would be an advantage, but if *not*, these being even to a lessened extent allowed to come in contact with young live bark would do a deal of mischief. The kinds of " axle grease " or " lubricants " containing petroleum or petroleum residue would also be very injurious.*

Prevention by greased hay ropes laid on the ground so as to encircle the guarded tree.

The following communication with which I was favoured on Nov. 20th by Mr. Arkwright, of Hampton Court, Leominster, is well worth notice :—" I visited my orchards which have been treated with cart grease three weeks ago, and found the hay bands in perfect order and catching every living creeper. The grease had not melted or hardened, and I am perfectly certain that no crawling creature could pass the band.

" I twisted hay round a piece of cocoa-nut string such as they use for Hops, and tied it as tight as I could round the trees ; afterwards painting the under angle of outside with the common grease bought in tins for cart wheels. Common cart grease bought in 14 lb. tins at Ballow & Co., Leominster. It comes to about 2d. a pound."—(J. H. A.)

With this communication, Mr. Arkwright was good enough to send a hay band for examination which appeared to be answering its purpose very thoroughly. The grease was still quite soft and tenacious, and the method of applying it mentioned by Mr. Arkwright meets (so far as I can see) the practical objection to the use of tar or grease hay-

* For more special notes on these see pp. 59 and 60 of my '13th Report on Injurious Insects,' where are also references to recipes in a paper on lubricants in 'Workshop Recipes,' by C. Warneford Locke, published by E. & F. N. Spon, Charing Cross, London.

banding on the ground, namely, that the moths harboured under the edge.

In the case of the sample sent me, the sodden greasy mass seemed very deterrent to any such harbourage, and the plan altogether to be a cheap convenient form of banding, well worth drawing attention to. If further tried I should be glad of any reports regarding it, as if generally successful the simple method, only needing some hay and string and common cart-grease, would often be used where measures requiring more purchase of material, and more care in applying, would not be carried out.

Time of appearance of the moths.—The variableness of date of appearance in different localities, or in one locality under different circumstances is a troublesome point practically. In the past autumn, Mr. Wise wrote me, from Toddington (near Gloucester), that the first female Winter Moth was caught on the 17th of October, one day earlier than last year. Mr. Hiam writing from Astwood Bank, near Redditch, at the date of Nov. 8th, mentioned that the Winter Moths were then being taken in quantities in the grease bands, and that the first appearance had been observed a fortnight before.

At Glewstone Court, Ross, Herefordshire, Mr. C. Lee Campbell, writing on the 4th Dec., mentioned, "The Winter Moth put in its appearance here at last, a month later than last year;" and at Croome Court, Severn Stoke, Worcestershire, in observations with which I was favoured by Lord Coventry, it was noticed (a little prior to the 22nd of Nov.) that "the greasing was commenced about a fortnight ago, but at present no results have been observed." On the 22nd a report was sent that "the wingless moths are now ascending the trees, and are being caught in the grease bands in large numbers," and also that many winged moths were caught in the smear.

The foregoing observations, taken at places no great distance from each other, give a range of somewhere about a month in difference in date of first appearance, and there does not appear to be any way of meeting this difficulty practically, excepting by having examinations carefully kept up by an observer going with a lanthorn for successive evenings after sunset, or till towards 10 o'clock, to see whether the moths are ascending. Or if this plan is too troublesome, beginning as soon as ever moth presence may be expected, and having a few trees grease-banded and examined daily as to amount of capture. The matter of coincidence of date in first greasing, and first appearance of moths, is of a good deal of importance, or on one hand there will be a waste on the drying grease, or on the other a chance of the ascent of the moths preceding the application of the sticky-banding.

Paris-green.—Up to the present year, sticky-banding has appeared

to be the only reliable measure for us to depend on in this country, in order to stop the ascent of Winter Moths, or other wingless kinds of moths, which creep up the stems of orchard trees to lay their eggs on the branches. But, at the same time, it has become more and more plain each year that although sticky-banding is so far of service, that in many cases the foliage of orchard trees would have been totally destroyed if the banding had not been done, yet still that it is only a partial protection against *wingless* moths gaining access to the trees for egg-laying, and is no protection at all from the many kinds of attack originated by *winged* infestations: also it is expensive, needs renewing at intervals, and, without special arrangements to insure safety to bark, is detrimental to the health of the trees.

Some kind of application was greatly needed which was cheap and sure in its action, and which could be brought to bear at once when required on any or all sorts of moth caterpillars together (whatever their various natures or previous histories may have been), and would kill the whole collection of ravaging hordes at once, but without damaging the leafage.

For some years back trials have been made, in many isolated cases, of various kinds of treatment which it was hoped *might* lessen the hordes of caterpillars which now yearly cause great injury to leafage of our orchards; but as these experiments were seldom carefully recorded as to details or results, they have been of little public benefit.

It therefore seemed desirable to form a regular Experimental Committee, of members cognisant of all the needs of the case, and also *known to be qualified*, both practically and scientifically, to superintend experiments in orchard treatment, and report results.

Accordingly, about the end of February in this year, 1890, at a conference of fruit growers held at Evesham, a Committee of Experiment was formed, of gentlemen personally interested in the subject, as land owners or fruit growers on a large scale, or superintendents of large fruit grounds, or in other ways much concerned in the preservation of orchard crops.*

* The Committee consisted of Mr. Gibbon, of Seaford Grange, Pershore (who has given valuable aid to the Committee as Chairman); Mr. J. Masters, of Evesham, Hon. Sec.; Capt. Corbett and Mr. C. D. Wise (respectively Superintendent and Deputy-Superintendent at the great Toddington Fruit Grounds); Mr. Swift, a large land owner and occupier of land in the neighbourhood; Mr. Doeg, of Evesham; and Mr. Hiam, of Astwood Bank; likewise Mr. F. Hooper and Mr. E. Grove. I rendered what assistance lay in my power as the Consulting Entomologist of the Committee, and we were greatly favoured by being allowed in all difficulties to apply for advice to Mr. J. Fletcher, the Entomologist of the Dominion of Canada; and thus knew that so far as we followed instructions we were trying no new thing, but what had been known to answer in Canada and America for regular orchard service for years back.

The plan of operation was for the members to try the effect of any kind of sprays, washes, or other applications which they might judge likely to be effective in destroying the caterpillars on orchard trees without injuring the leafage; and to meet at various different centres from time to time, so that the whole Committee could judge of results of various treatments, and consultation and detailed reports of the method of treatment take place, or be given by the members. Also, as it was before us all, in reports of the Agricultural Departments and State Entomologists of Canada and the United States, that for years back attacks to orchard trees, perfectly similar in their nature to those which have been causing us such loss here, were lessened or wholly prevented there by applications of spraying with the chemical known as Paris- or Emerald-green, of which we had full working details,—one especial part of the work of the Committee of Experiment was to test the serviceableness of this especial application in our rather different climate, and with (at that time) our inferior apparatus for throwing fluid.

This plan was thoroughly carried out, and amongst the special consultations may be mentioned the meeting at the Toddington Fruit Grounds on the 1st of May; also at Seaford Grange, the residence of the Chairman of the Committee, on the 14th of the same month; and on the 11th of June, to inspect the plantations of Messrs. Masters & Groves at Greenhill. At these meetings the several experiences of the members were given, showing clearly that, even under careful experiment, just the same uncertainty occurred, with regard to good effects of *almost* all the applications, as has appeared to be the case for years back. Alum, hellebore, chrysoline, ammoniacal liquor, &c., were reported on, and sometimes found useful; sometimes, as in the case of alum, found occasionally useful, but also, and on very careful trial elsewhere, of not the slightest service; and later on, when the caterpillar was more advanced, the alum was found to be of no service at all.

Full reports of the information given by the members and the discussions thereon, likewise their reports of the condition of the trees experimented on, were given at the time in the local journals, so as to be preserved in detail and accessible for reference; * but the results embodied in the recommendation of the Experimental Committee, given after their consultation on May 3rd at the Toddington Fruit Grounds, may, so far as “Paris-green” is concerned, be rested on as confirmed by repeated trial subsequently, and the good results shown by the autumn returns of fruit in such cases as I have report of.

The Committee, in reply to the statement that “many people were

* See especially ‘Evesham Journal’ and ‘Evesham Standard,’ of dates of Saturdays immediately following days of meeting, named above.

waiting to give the mixtures recommended a trial," decided that they could recommend the following :—Paris-green paste in the proportion of 1 oz. to 8 or 10 gallons of water for Plums, and 1 oz. to 20 gallons of water for Apples ;* London-fluid, one part to twenty parts of water. † Both these they recommend as effective in destroying the caterpillar, while they did no material harm to the leafage.

The proportion above mentioned should not be exceeded. Capt. Corbett, in finishing his report of the Toddington experiments at the above meeting, mentioned that, "With regard to Apples, it seemed to them that the foliage was much more tender than that of Plum trees, and they thought that one ounce of Paris-green to twenty gallons of water was the proper preparation for them" (*i. e.*, for Apples, *Ed.*). "He wished to be very guarded about the blossom. He was only speaking of the foliage. The Pears should be treated as the Apples were." Mr. Masters added to the observations, on the part of the Committee, that they considered the syringing should be done when the leaf bud was first developed, before the blossoming period, and then again after the blossoms had disappeared and the fruit was forming.

The following note, sent me by Mr. Wise from Toddington, in order that I might be able to report results of our work to the Seeds and Plants Diseases Committee of the Royal Agricultural Society of England, on the 3rd of June, confirms the previous observations :— "We have, as you know, tried all sorts of mixtures, and I do not think it is worth while troubling you with all particulars of them, as they were all useless, or nearly so. Paris-green is the only thing which we have found really efficacious. For Plums the proportion is 1 oz. to 10 gallons, and for Apples 1 oz. to 20 gallons. We have also used the former strength for Currants, but as the foliage is within the last few days becoming so much stronger, we have been using it at 1 oz. to 8 gallons. Neither of these solutions has damaged the foliage, but killed the caterpillar."—(C. D. W.) ‡

The following remarks, sent early in the year by Mr. Fletcher, Dominion Entomologist of Canada, who assisted us greatly by his

* "Paris-green paste." Arrangements have been made by which the Paris-green powder may be furnished in a slightly damped condition, so as to do away with all danger of the dust being inhaled in mixing.

† "London-fluid." This is a fluid form of the arsenical preparation known as "London-purple," prepared by Messrs. Hemingway, London, who liberally presented a large supply for experiment. It is preferred by some orchardists to the Paris-green, and, as will be seen in the following notes, was used with success in some instances. But the experiments of the Committee pointed to the Paris-green as being more reliable.

‡ Notes with regard to *un-desirableness* of spraying on the blossom, also as to serviceable kinds of engines, or apparatus for delivery of the spray, and other necessary details, will be found under their respective headings.

skilled as well as practical advice, are well worth notice :—"Begin with too weak mixtures rather than too strong. Weak mixtures, although slower, are yet quite sure in their work. In your damp climate, too, it *might* be the case that the effects on foliage might be more injurious than in our dry air."—(J. F.)

It is somewhat curious that whilst in Canada, as observed by Mr. Fletcher in a part of the letter quoted above, "Paris-green is more injurious to Plums than to Apples," here the reverse, so far as we see at present, is the case. The proportion used for Apples is only half the strength of that which may safely be applied to Plums.—ED.

The following note of operations, sent on June 28th by Mr. John Riley, of Putley Court, Ledbury, is very well worth reading relatively to all the points entered on; notably success in destroying moth caterpillars by use of Paris-green, and without damage to foliage. Also *non*-success in killing Aphides with this application, and *success* in use of *soft-soap* and quassia. I should like particularly to draw attention to this. It is not generally enough considered that Aphides feed by suction. They thrust their suckers down into the soft tissues on the juices of which they feed, and consequently are by no means certain to be hurt by poisonous matters lying *on the surface* of these leaves or shoots. The soft-soap adheres to them, and so chokes up their breathing-pores, and if anything can be added to the soft-soap which will injure these Aphides or Green Fly by being absorbed into them, it will be so much the better; but Paris-green will not kill them (as it does the caterpillars) by means of their eating the poisoned surface:—

"We tried Paris-green, London-purple, and chrysoline for the caterpillars. We began late, when the caterpillar was strong. Paris-green we found by far the best; it killed nearly all the caterpillars in a short time, and did not damage the foliage at all. It was used as recommended by your Committee. We afterwards tried it for Aphis, which was doing great damage to Plum trees and Damsons, at 1 lb. to 100 gallons; this did not injure the foliage at all, but the Aphis did not in the least mind the application, and I have since had to wash with soft-soap and quassia, which was quite effectual. London-purple injured the foliage a little, and was not nearly as effective as Paris-green used as recommended. Chrysoline was also not so effective as Paris-green. In the Grass orchards I used alum, from 2 to 3½ oz. to the gallon—caterpillars strong; I think it rather checked them, but it did not kill many. I doubt if I saved much fruit by it, but perhaps the leaves were not so completely destroyed as they otherwise would have been. I had a jug of about 2 quarts with 4 ozs. of alum in, well mixed, and I bent down a sprig of Plum covered with Aphis into the solution, and the foliage was not injured, and the Aphis quite uninjured too."—(John Riley.)

The following observations, sent by Messrs. Salmon, of Sutton Farm, near Hounslow, show beneficial effects of applications of Paris-green, even without any more special appliances for distributing the spray than our ordinary garden engines. On the 17th of April Messrs. Salmon first wrote to me mentioning that they were greatly troubled with the blight, and had tried sulphate of copper on some of their young trees, but were afraid of injuring the buds.

In reply to the enquiries sent, I suggested trial of Paris-green, and six days later (on the 23rd of April) Messrs. Salmon wrote me:—"We are using Paris-green, and find it very effectual; we have two men on continually with garden engine."

At the end of May, being desirous to learn results, I wrote to Messrs. Salmon, and received the following very satisfactory reply:—"All we can say to it is to its advantage. It has succeeded admirably. The trees look healthier and better, with as much fruit (if not more) on as anywhere else; they are beautifully clean. It has not injured the foliage in the slightest. We shall always use it in case of blight."

The following is a short summary of results, and consideration of the position of our experimental work up to date, which was sent me by Capt. R. J. Corbett on the 3rd of July from Toddington:—"I have lately returned from France, and have been anxious to see the result of the experiments in spraying. First, I will say that the proportions I fixed upon after the first trials, *viz.*, 1 oz. to 10 gallons of water for Plums, and 1 oz. to 20 gallons of water for Apples, must not be exceeded. Even with these proportions I think the end of the leaves in some cases have been scorched. Our crop of Plums is the best we can hear of, though much loss has come from the Green Fly. I think that this pest" (caterpillar pest, Ed.) "can, and ought to be, kept under control, and that a more persistent course of spraying would have done so. Do you not think it would? It seems to me that we have made a good beginning this year, and that next year we shall, by reason of experience gained, do a great deal better—in fact, I believe we can now keep the enemy under."—(R. J. C.)

In some cases a rather stronger proportion of Paris-green than that named was used safely, and in the course of June, Mr. Masters, of Evesham, favoured me with the following note regarding mixture of flour with the green:—"When the foliage of trees is young and tender, I do not think it safe to apply the Paris-green stronger than in the proportion of 1 oz. to 10 gallons of water. But when the foliage is matured, and the caterpillar is full-grown, a solution of 1 oz. Paris-green to 6 gallons of water may be safely used; for every case it would be well to use about 2 lbs. of fine wheat flour to every pound of Paris-green; it thickens the solution, and prevents the particles of Paris-

green from settling at the bottom of the vessel, and, when it is sprayed, helps to secrete the preparation on the foliage.”*

There is, however, so very much fear in first experiments of too strong a mixture being given that, though with care a larger proportion of “green” may serviceably be used, as will be seen in the following extract, the Committee did not undertake to *recommend* a stronger application:—

For liquid application.—The amount recommended for spraying for Codlin Moth or young “looper” caterpillar is “not more than from 2 to 4 ozs. in 40 (forty) gallons of water, or $\frac{1}{8}$ to $\frac{1}{4}$ oz. in a pail of water (4 gallons, E. A. O.), to be applied as a fine spray by means of a force-pump. The foliage must not be drenched, but the spray should only be allowed to fall upon the trees until it begins to drop from the leaves.”

“*For general use on mature foliage.*— $\frac{1}{2}$ lb. of Paris-green, 50 gallons of water. First mix the Paris-green separately with a small quantity of water, then add to it the whole supply. All washes containing Paris-green must be constantly stirred to keep it in suspension, or it will sink to the bottom.”†

On these points Mr. Fletcher, the Dominion Entomologist of Canada, who greatly assisted us by his valuable advice, wrote to me enforcing care as to over-application:—

“*Paris-green.*—You are quite safe in recommending this; but insist upon these two things, *viz.*, 1st, to keep the mixture (which is a mixture, not a solution) well stirred all the time, and have the barrel well washed out after it has been filled ten or twelve times. The Paris-green is very heavy, and will keep sinking to the bottom unless constantly agitated, and as the barrel is frequently re-filled the residue will keep accumulating, until it will be too strong as the mixture reaches the bottom.

“2ndly. The other point is to insist upon the mixture not being

* The above observation by Mr. Masters is the only notice received of trial of mixture of flour with the “green.” This practice, however, is highly recommended by Prof. C. V. Riley, Entomologist of the Department of Agriculture, U.S.A. In his ‘Bulletin No. 3 of the United States Entomological Commission,’ Washington, 1880, at p. 57 he mentions in observations on use of Paris-green in liquid suspension:—“It pays to add two or three pounds of flour or starch to the mixture, not only from the greater adhesiveness which they give to the poison (a very desirable object, especially in wet weather), but because by their colour they help to indicate the quantity that has been distributed. In using flour it will be found advisable to mix it first in a bucketful of water, and allow it to remain until it sours, the object being to prevent it from forming lumps.” If any further experiment should be made with this admixture, I should be glad of notes as to whether the flour is in any way injurious by choking up the pores, or too thickly covering the leaves.—ED.

† ‘Report of Entomologist, Central Experimental Farm, Department of Agriculture, Canada,’ 1887, p. 21.

made too strong; 1 lb. to 200 gallons I find very useful, and I never use stronger than 1 lb. to 120 gallons."—(J. F.)

With regard to method of application of the spray.—This should be thrown so finely as to reach all parts of the tree, and both sides of the leaves, and coat the leaves as with a fine dew, but it should *not* be allowed to run down and drip. As soon as dripping begins spraying should cease.

It should not be done whilst the trees are in blossom, and warning is also given in the American works that sprayings should not be given in rapid succession. Several days, it is advised, should elapse between, unless of course, as may easily happen in difficulties of first experiments, the spray was manifestly so weak that the application counted for nothing. The effect of the Paris-green on the caterpillars does not always show directly, and it is undesirable to waste labour and material where the work is already done, and only requires a day or two to show it.

Our work was much held back at first in many ways, as all new introductions commonly are; partly by objections, some founded, some unfounded (chiefly the latter), and especially from writers who appeared totally unacquainted with the fact that the *reason of our* work was that the applications *they advocated* had been tried for years, and proved *useless*; partly also, and very greatly, we were held back by want of proper apparatus. As pointed out by Mr. Masters at the Committee-meeting at Evesham in October:—"In this emergency resort was made to ordinary syringes, garden engines, or any apparatus at hand to spray the foliage of the trees." . . . "If a Strawsonizer could have been used, it is probable that one pint of poisoned liquid diffused in its misty particles would have been an ample supply to bedew and poison every leaf in the largest tree." . . . "Added to this is the irregularity of spraying, some of the boughs having a copious sousing, and some but very little."

These remarks of Mr. Masters', of which I regret that space only allows me to give a portion, are well worthy of notice, and I should like to direct the attention of my readers to the very practical lesson which may further be drawn from a little calculation based on these observations.

It is the very essence of our spraying work that *no "drip"* should take place, the spray should fall (or rise) as a haze and remain as dew, and 1 oz. of Paris-green to 10 gallons of water is the highest strength we recommend. This gives one-tenth of an ounce to one gallon of water, which would be a proportion of one-twentieth of an ounce to half a gallon, or two quarts, and half of this again would be the fortieth part of an ounce to one quart of water. Therefore, supposing instead of the pint of water (the amount named by Mr. Masters) dispersed as it should be (and quite easily could be by the Strawsonizer)

in misty dew on the leaves, we give twice the quantity, that is, a quart, we only distribute *one-fortieth of an ounce* of the Paris-green, of which, according to the percentage analysis, only about a third (32·11) is arsenic.

I think the above calculation is worth notice as a key at least to understanding the foundation and essence of success of our work, and also in order to be able to put it before those who endeavour to throw difficulties in the way of preserving our fruit crops by erroneous statements.

We do not work by washing the trees down with unlimited amounts of poison dropping from the leafage; if we did, it would serve no purpose. What is sent in fine film is intended to remain merely as a light dew on the leaves.

To recapitulate: taking, as I noted above, double the amount of spray estimated by Mr. Masters to be needed, this shows (to put it in plain words) the amount of arsenic deposited in film on the whole of the leafage of a large tree to be only *rather* less than the third of a fortieth part of an ounce—this on Plum, half that amount on Apple and Pear.

Non-feeding of animals under sprayed trees.—As, however, it is totally impossible to guard against what may be done by careless workers, or those who will not take the trouble to understand what they are about, in all *we* (that is to say, the Experimental Committee as a body and myself personally) are desired to advise on, we most scrupulously direct that *cattle and stock and other animals should never be allowed to pasture or feed under trees that are being, or have recently been, sprayed*, for fear of injury from feeding on Grass on which there may have been drip. We give no opening for possibility of mischief occurring from this cause where our advice is followed; but (having noted this duly) there is no harm in mentioning here that where the fine spraying is properly carried on, it is at least open to doubt whether any risk in the above way is incurred.

In the course of reporting, it appeared that one observer fed his mares and foals beneath the Paris-greened trees with no ill effects. Mr. Lee Campbell, of Glewstone Court, Ross, also alluding to this point, wrote me:—"You will recollect that I sprayed the trees this year ten times with Paris-green, partly 2 ozs. to the 20 gallons, and later with only one, and during the caterpillar season (in fact, all the year until the fruit was becoming ripe) fowls have had a free run all over the field."

I have also received a report to a similar effect from Messrs. Salmon, of Sutton, near Hounslow, who were very successful in the use of Paris-green, relatively to small birds. They informed me that they had neither found dead birds nor seen any signs of harm caused by the application in their sprayed orchard grounds.

With regard to Bees, as the trees should *not be sprayed when they are in blossom*, this gets over any fear of Bees being poisoned. But until the use and methods of application of Paris-green are thoroughly understood, we must still give the caution, whether needed or not, never to pasture or feed stock, poultry, or any other animals beneath trees which are being, or have recently been, sprayed with Paris-green.

Further on I give notes as to the nature of Paris- or Emerald-green, and cautions as to the points that need to be attended to in its use; also notes of appliances for its proper distribution; but (in order to give the observations in some sort of continuity) I add from those received two of the most notable from known observers of our success in saving the fruit crops, with observations of the satisfactory diminution of Winter Moth presence, found at sticky-banding time in autumn, where our treatment had been carefully carried out.

Report of Plum crop at Toddington.—On September 4th, Mr. Wise gave the following satisfactory report, from the Toddington Fruit Grounds, of the condition of the Plum crop:—"I am making preparations for commencing the operation of grease-banding on October 1st. You will be pleased to hear that we have a grand crop of Plums, and I attribute this entirely to our exertions in keeping down caterpillars. No one else in the country appears to have many, and we are making fabulous prices."

It must be borne in mind (independently of the especial considerations which are the subject of this paper) that the large output of 510 tons of out-door fruit, which has been harvested at Toddington this season, and which has been noticed in so many of the newspapers, has, of course, to be counter-balanced by the large amount of expenditure incurred; and that, whilst fruit-farming will certainly pay those who can patiently wait, still it is a matter which must not in any way be looked upon as a profitable venture without a good deal of uncertainty in the early years of its formation.

But the greater the outlay on this importantly increasing branch of British farm industry, the greater is also the need to have at hand the best means of preventing the results of the outlay being as rapidly and fully swept from the trees as if a devastation of locusts had taken possession; and I think I can do no wrong in adding that, in almost the latest letter which I received from Captain Corbett, the Superintendent of the Toddington Fruit Grounds, shortly before his much-to-be-regretted decease, he spoke in the strongest terms of the benefit received in saving the fruit crops by means of the spraying treatment, on which we had been so carefully experimenting.

Mr. Masters, of Evesham, also, as noted in the following observa-

tions, sent on the same date as the above, benefited greatly by his careful treatment of his trees:—"We are very busy finishing the fruit-picking. I am pleased to say I have been fortunate this season, having had a considerable crop of Plums, and which have been selling at high prices. My neighbours are now, from my success, beginning to realise the importance of taking proper precautions."

Diminution of amount of appearance of Winter Moth in the past autumn.—Mr. J. Masters, writing from Evesham, on the 30th October, remarked:—"The point you especially refer to of the diminution of the pest, I find already is the case. Some of my plantations that were some years ago so badly infested are now so free from the Winter Moth that even last year, notwithstanding our grease-banding, we could scarcely capture one single moth; and here we were rewarded with heavy crops of Plums this season."

The following observations, sent me a few days after (on the 5th of November) from Toddington, by Mr. C. D. Wise, give a most satisfactory account of the gradual lessening (where preventive measures have been taken) of amount of Winter Moths captured on the grease-bands, of the great diminution in the number as then compared to what the number was three years ago, and also the very noticeable fact that in a plantation which had been syringed, with the exception of one acre, with Paris-green, that on this one acre more Winter Moths were captured than anywhere else. Mr. Wise wrote:—

"You will be interested to hear that we caught the first female Winter Moth on the 17th October, one day earlier than last year; also that we are catching very few this season, the greatest number I have seen on a tree being nine. This is a vast difference to three years ago, when we counted as many as 500 on one tree, and I think it shows that all our trouble has not been in vain.

"You will remember that I reported to you last year that the number of moths caught greatly decreased in number as compared with the former year; now this year, as we are catching so very few, I think it is most satisfactory.

"You will be interested to hear that in one plantation where we syringed with Paris-green, and where the men in doing so emptied their buckets before they got to the end of the row, and left about one acre unsyringed; on this one acre we have caught more Winter Moths than we have anywhere, and this shows conclusively what the syringing did for us.

"I really think next year we shall be able to use narrower bands on the trees. This will save paper and grease."—C. D. W.

Rather later on—the 19th of November—Mr. Wise further reported, "We are still catching very few moths."

On Nov. 20th, Mr. J. Hiam, of Astwood Bank, Redditch, who has

bestowed much attention on the subject of caterpillar prevention, and who, as well as the two above-named gentlemen, is a member of the Evesham Fruit Conference Experimental Committee, wrote me that he "found a wonderful difference in the quantity of moths caught on the grease bands on trees syringed with Paris-green in the summer, or rather in late spring, and those not syringed. Trees growing side by side have hundreds of moths caught in the one case, and comparatively none on trees dressed."

I gladly accepted Mr. Hiam's offer to furnish me with precise details of treatment and results, as these records are just what are of so much value to possess and so difficult to procure. Therefore I give Mr. Hiam's Report, sent me on Nov. 22nd, verbatim as follows:—

"The following brief remarks are respecting the results of my experiments with London-purple and Paris-green, in connection with the Evesham Experimental Committee on Fruit Pests."—J. H.

"No. 1.—London-purple fluid, applied to an Apple tree early in April before the buds had opened, and when the caterpillars of the Winter Moth were hatching out. Strength, 20 parts of water to 1 of London-purple, applied with a fine nozzle syringe. Second application after bloom had set.

"*Results.*—A fine crop of very clean nice fruit.

"Band of grease dressing applied to tree stem on waterproof paper early in October: not a moth caught, neither male or female, although the band is in excellent condition.

"No. 2.—Apple tree syringed with Paris-green before the buds expanded, and again after the fruit had formed. Strength, 1 oz. to 10 gallons of water.

"*Excellent results.*—Tree laden very heavily with medium-sized fruit.

"Grease band has caught one female moth and four males.

"No. 3.—Standard orchard Apple tree, 20 in. circumference, syringed with Paris-green after (but not before) blooming.

"*Results.*—Very little fruit.

"Caught on grease band three females and fourteen male moths.

"No. 4.—Standard orchard Apple tree, 36 in. circumference. Syringed with Paris-green too late to save the bloom.

"Caught on grease band three females and twenty-one males.

"No. 5.—21 in. circumference. Syringed with Paris-green somewhat earlier than No. 6" [precise date omitted, Ed.], "but probably by about the end of April: this is *too late* for the first application for some kinds of Apples. It bore some fruit.

"Four females, twenty-two males.

"No. 6.—30 in. circumference. Was syringed with Paris-green about the end of May, when it was apparent that the caterpillars were fast clearing it. It had only one dressing, and the foliage which

appeared afterwards was free from caterpillars, showing that the application was satisfactory.

“ Six females, eight males.

“ No. 7.—*Not* Syringed with any insecticide, 57 inches circumference. One hundred and thirty-eight females, one hundred and three males. Bore *two Apples* only.

“ No. 8.—*Not* syringed with any insecticide, 34 inches circumference. Eighty-two females, eighty-five males. Bore about half a peck of Apples.

“ No. 9.—Tree partly syringed with London-purple, early before buds expanded. The portion of the tree syringed bore a nice crop of Apples of good quality ; foliage good.

“ The portion of the tree not syringed bore very little fruit, and the foliage was very badly damaged.

“ Grease bands ; about two-thirds of the trunk banded with waterproof paper, on twenty-seven inches of the circumference, eighty-five females, fifty-three males.

“ Nine inches of the bark was dressed direct (without any paper), on which two females and two males only were caught, thus showing the effect of absorption of the sticky part of the dressing by the bark.”—(J. H.)

To the above report Mr. Hiam added the following summary :—

“ Six trees syringed, on which were placed 128 in. of bands. Moths caught, females 17, males 69.

“ Three trees, two of which were unsyringed, and one partly so. 118 in. of band. Females caught 305, males 241.”

Looking at the season's work as a whole, also from the well qualified opinion given by Capt. Corbett on the careful trials at Toddington, and opinions sent me in reply to my successive reports, by the Dominion Entomologist of Canada, I consider it cannot be looked on as other than a *success*.

We had many failures. These must be always expected in trying new measures, but we can trace these very especially to want of apparatus, and also notably to the proportions *advised* not being adhered to. There was an alarm as to leaves of trees dropping, but so far as report has been given me, and special report was sent at my request, this was for the most part where over-quantity of the chemical was used.

Rather unfortunately for our steady progress, an experiment was made by one observer of giving an enormously strong overdose, which application was crowned with the *fullest success*. The caterpillars were killed and the leafage was uninjured. The reason of this was easily traceable, to the fact of such rainfall as washed the leafage clean almost immediately following ; but meanwhile, encouragement was

given to all who were inclined to think that if good was done by a weak application much more would be done by a strong one, and *where* over-doses took place (without accidental help from rainfall), injury followed.

The only point which has come under my notice in the enormous quantity of reporting sent to my hands on the subject, that does not appear as yet to be quite clear is whether bright sunshine soon after spraying does or does not cause it to have some degree of injurious effect. In the coming season when we may have the benefit of apparatus to throw the fine hazy moisture in the proper manner, this difficulty will probably vanish.

But we have now *proof* from thoroughly publicly tried experiments on a working scale, that here, as in America, when properly applied the Paris-green mixture will kill the caterpillars without injuring the leafage; that these operations have been followed by an exceedingly good harvesting of fruit, and this again by a good promise for next year by the amount of forming buds on the trees, and by notable diminution of Winter Moth appearance in autumn.

Our experiments have been mainly directed to, and the reports mainly concern, Paris-green. Though some observers have experimented and thought well of the arsenical preparation known as London-purple, in *these* notes and recommendations, I have strictly limited myself to Paris-green, which I can give evidence of successful use of, from the Government reports of the United States and Canada, and of publicly tried and tested experiment here.*

Nature of Paris or Emerald-green, and cautions requisite to be observed in its use.—"Paris-green" is an aceto-arsenite of copper, and of a poisonous nature, and therefore should be used with care in mixing, and should not be applied *to fruit or to vegetables that are used for food*. But, as will have been seen in the previous observations, the quantity to which it, in order to be beneficial, is requisite to limit application in spraying for prevention of moth caterpillars (see p. 86) is excessively small, and our English experiences of the past season, as well as those on the Continent of America where Paris-green has been used regularly in farm and orchard prevention for many years, show that with proper care it may be used with perfect safety.

On application to Messrs. Blundell & Spence, of Hull, as being well known manufacturers and great exporters of Paris-green, for information as to the precise constituents of this chemical, and the different names under which it was described, Mr. E. Dixon (Manager) replied to me as follows:—"Emerald-green, Paris-green, Schweinfurth-green, are different names for the same thing. The first name is

* For paper on nature and serviceableness of London-purple see Index.

English, and is the one used in most of our Colonies, India, and China; the second is the American term; the third only used in Germany and by German traders.

“Emerald or Paris-green is a double salt of arsenite and acetate of copper,—in other words, an aceto-arsenite of copper. You may take the U.S.A. analysis of Paris-green as correct. The pure article (which is that used as an insecticide) is a true crystal, and varies in colour, from a deep to a pale green, according to the size of the crystals.”

Mr. Dixon also favoured me with the following percentage analysis of pure Emerald- or Paris-green.

“Percentage composition of Emerald-green:—

	Per cent.
“Copper . . .	32.11
Arsenic . . .	28.56
Oxygen . . .	32.48
Hydrogen . . .	0.76
Carbon . . .	6.09
Total . . .	100.00 ”

Cautions to be observed in the use of Paris-green.—The bags should be labelled POISON and kept locked up, and especially kept safely out of the way of children, who might be attracted by the beautiful colour.

Workers with the powder should not allow it to settle in any sore or crack in the skin of the hands, nor stir it about unnecessarily with the hands; and they should be *very careful not to breathe in the powder* through mouth or nose whilst measuring or mixing it.

For this reason it is most desirable that purchasers of Paris-green should have it sent *not* in bulk, to be divided for use on receipt, but wrapped in single pound (or small) packages by the senders. I particularly wish to draw attention to Mr. Dixon’s observations on this head, given in his replies to my enquiries:—

“In handling this article in the dry powder, care is required, as a light green dust arises which is breathed in, and produces unpleasant results; and in one instance, a customer who thought he could save money by buying it from us in bulk, putting it up himself in paper parcels, employed a man to weigh out and wrap about 5 cwt. in 1 lb. parcels. *This cost the man his life*; so as we are laid out for this business, sometimes wrapping 10 tons a week, we can really do it at much less cost.

“We have never heard of any accident to users in America, and there is no danger when using it in water (*i. e.* from its flying about, Ed.), but you might advise any who wish to try dusting it on dry to carefully stand to windward.”—(E. Dixon (Director), Messrs. Blundell & Spence, Hull.)*

* At present we especially advise that *dry dusting should not* be attempted as a remedy for caterpillar attack. We only advise fluid mixture.

In order further to remove risk from inhaling dust in process of mixing, Messrs. Blundell & Spence arranged that where wished they would slightly moisten the powder before forwarding it to the purchaser; this is the form known as "Paris-green paste," which is mentioned in the recommendations of the Experimental Committee.

In use, the above directions should be followed; in fact, ordinary care and caution should be used; like others of the poisons which are used in various agricultural treatments, Paris-green may be used without the slightest danger or damage *if* reasonable care is taken; if not, there is necessarily a possibility, in this as in other cases, of disagreeable effects or dangerous illness ensuing, or *possibly* death.

The cost of the Paris-green is very little.—The firm with whom I have corresponded on the subject inform me that, as wholesale manufacturers, they could furnish quantities of 1 cwt. and over, at the rate of 10d. per lb. Retail traders would probably not furnish the pure article under 1s. 3d. per lb.

In the use of Paris-green as a fluid dressing, or spray, one of the first points to be borne in mind is that this chemical does *not* dissolve in water. It is simply held in suspension. The powder merely mixes with the water, and unless this mixture is kept stirred, the Paris-green powder will sink to the bottom of the barrel, pump, or other apparatus, instead of being evenly distributed throughout the fluid.

For this reason it is necessary to keep the mixture in agitation during application, and also it is necessary to have the barrel "well washed out after it has been filled ten or twelve times." If this is not done the mixture will very soon be too weak at the top and too strong at the bottom, and the gradually increasing settlement will presently (in all probability) cause a seriously too strong overdose.

One great point therefore, in selection of spraying machines, is that either by mechanical contrivances (when on a large scale), or in the portable forms by arrangements which will make the movement of the bearer serve the same purpose, the mixture should be so kept in movement that the powder should not settle down. The mixture should be kept at an even strength throughout, during the whole time of distribution, and also it should be so distributed that it will be thrown as a fine spray, or mist, and will *rest and remain* both on the upper and under sides of the sprayed leafage as a fine film or dew.

It should on no account whatever be thrown so as to "swill" or "souse" the trees, and run off the leaves in drops, or streams; this is bad practice in every way. It uses a great deal more of the chemical than is needed; the leaves get little but pure water at their highest part, and much too strong application where the fluid has settled at the tips; and also a drip is caused on to the ground beneath, which may render the grass temporarily poisonous.

To recapitulate, the mixture should be of an even strength (specified on previous pages repeatedly), which strength should never be exceeded for our present consideration of spraying for moth caterpillars, and this mixture should be distributed so as to remain in the finest film of moisture. This point should always be borne in mind.

Various forms of apparatus would answer this purpose, but with regard to what has been tried and found to answer well at Toddington Fruit Grounds, in our past season's experiments, I was favoured by Capt. Corbett (in July last) with the following note:—

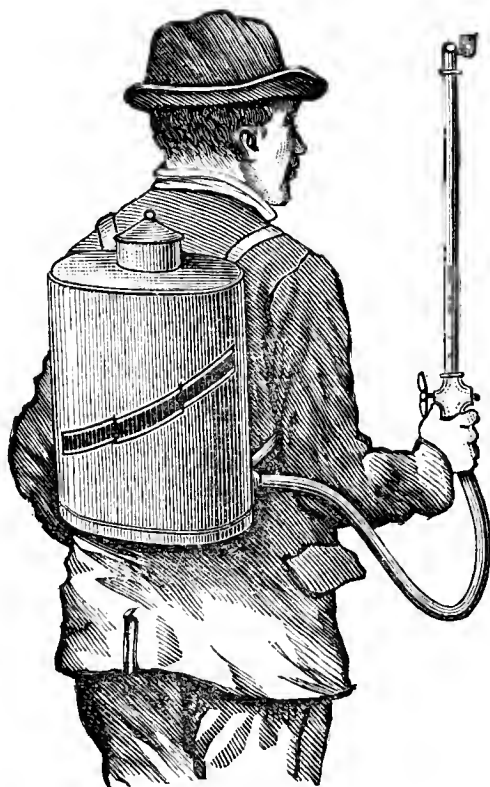
“The knapsack pump, or No. 1 ‘Eclair,’ used at Toddington plantations, can be had of Messrs. Chas. Clark and Co., Windsor Chambers, Great St. Helen's, E.C., sole agents.* One great advantage is that the movement of the man keeps the liquid agitated. It is an admirable instrument, and we like it better than anything.”—(R. J. C.)

On the 24th of December, Mr. J. Masters, of Evesham, wrote me regarding this “Eclair” spraying machine:—“The ‘knapsack’ form is everything that could be desired in producing the fine misty spray, and it is admirably adapted for trees and bushes not exceeding twelve to fourteen feet high. Above that height we must get either the Strawsonizer, or the force pump with a fine nozzle.”—(J. M.)

Mr. C. Lee Campbell, also writing to me on this subject from Glewstone Court, Ross, Herefordshire, observed:—“The little French machines used at Toddington are admirable in the hands of a painstaking man, and are the only machines which I have heard of that can be used where the ground is packed, as it is there, with undergrowth of bush plants, &c. But to my mind we should leave nothing to chance;” and here Mr. Lee Campbell mentioned an arrangement of dashers which at his suggestion was being added to another and much larger form of spraying machine (mentioned further on), by means of which the Paris-green was kept thoroughly mixed in the water without depending on the care of the operator.

* The decease of Capt. Corbett interrupted the arrangements which he had almost completed between M. Vermorel (Villefranche, Rhone, France), the manufacturers of the “Eclair” sprayer, and Messrs. Chas. Clark & Co., the sole English agents. I therefore recently made arrangements myself that a few of the sprayers should be imported on my own responsibility (so that in case of these not finding purchasers the loss might fall on myself), and that we should not again be without requisite apparatus. The price, I understand, will in some degree depend on numbers that can be imported at once, but may be generally stated at about 35/-. All communications with regard to purchase should be sent to Messrs. Chas. Clark & Co., Windsor Chambers, Great St. Helen's, London, E.C.

The sketch below (from M. Vermorel's circulars) shows the method of carrying the "knapsack." The sample I have seen fits well and

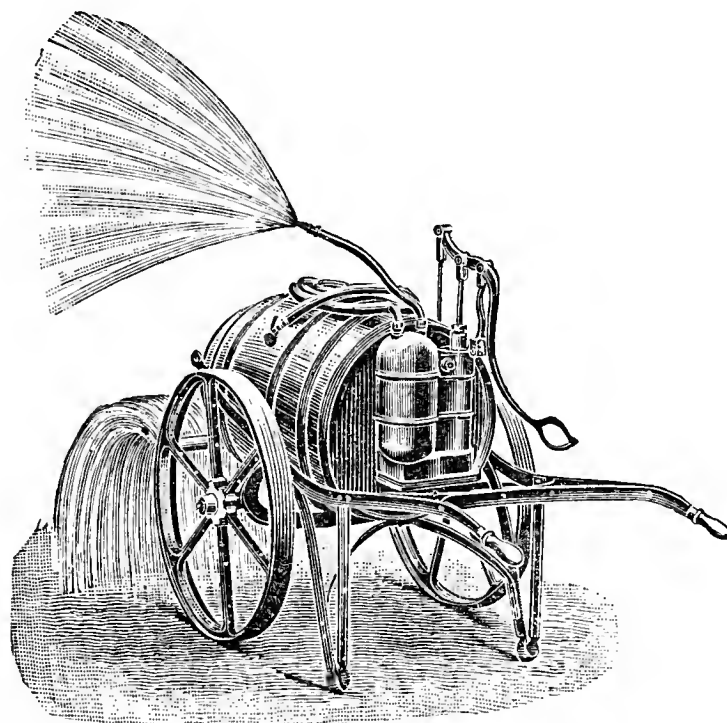


easily on the shoulders. It is a metal reservoir, solid, or rather standing on a deep strong rim below, so that when set on the ground it will stand safely, without necessitating help from a worker to hold the apparatus up whilst another fills it. A large opening, with moveable lid and wire sieve within, allows of the apparatus being quickly filled, and (when the sieve is lifted out) also permits of entrance of the hand to clean the inside, and there is automatic arrangement for keeping the mixture in movement. The distribution is effected by a hose attached to the reservoir or knapsack, with requisite arrangements and adjustable nozzle to distribute the application as a fine spray or mist. The reservoir may contain about three and a half gallons.

In the paper on insecticides recently reprinted by the U.S.A. Department of Agriculture, Prof. C. V. Riley mentions the "Vermorel nozzle" as one of the most successful of the modifications of the "Riley nozzle" used in the States. The great advantage of this nozzle is that by a special arrangement it can be cleaned inside when it becomes clogged.

Another form of spraying machine has been mentioned to me by Mr. C. Lee Campbell, of Glewstone Court, Ross, who has given great attention to Paris-green spraying on his own orchards of about 6000 trees, during the past season, as being very serviceable. It is fitted with powerful pump and two jets and sprayers, and also automatic dashers for keeping the fluid properly mixed. The pumps will draw to a height of thirty to forty feet. The barrel holds about thirty-six gallons of water.

The figure below shows the method of distribution of the spray; the water flowing from the front of the barrel shows the machine as used for watering lawns, &c., but this arrangement need not be supplied unless wished.



This machine is manufactured by Messrs. Boulton & Paul, Rose Lane Works, Norwich, and the price is £8 15s. for the spraying machine and all its appliances, *without* the special arrangement for watering.

Of this sprayer, Mr. Lee Campbell favoured me with the following further description:—

“The barrel is of course mounted on wheels, and has a pump fixed to the rear with two delivery pipes, to which are attached whatever length of tubing (india rubber) may be necessary. Three men go with the apparatus, two men to spray, and one to pump. Should the wind, however, be rough, we cannot always use two sprayers. The two sprayers assist in drawing the barrel. The rapidity of spraying necessarily depends somewhat on the wind, because as the spray is effective at at least 50 feet in quiet weather, it follows that in bad weather we are reduced to operate on a smaller area. I am able to spray 3000 trees a day under ordinary circumstances. As to the dashers. It is impossible to trust the great proportion of labourers with the responsibility of agitating the liquid.” “To my mind we should leave nothing to chance; therefore Messrs. Boulton & Paul, at my suggestion, have arranged the pump by lengthening the handle beyond the pump, and fixing dashers in the barrel attached to the handle, so that with every movement of the pump handle, the dashers are agitating the liquid. Stott’s double sprayer, fixed to the end of the tubes, works admirably, and economises the liquid immensely, besides rendering it less needful for the men’s hands to be constantly wet.”

For work on a still larger scale, there appears every reason to hope that the distributor popularly known as the Strawsonizer, would be excellently serviceable. The successive trials of this "air drill" for distribution of dry dressings in the finest powder, or fluid dressings in misty spray, have been so fully placed before the agricultural public that there can be no reason to describe the general method of this distributor over again. But looking at the adaptibility for orchard spraying, it is satisfactory to know that both the horse power and hand power machines have, or can have, vertical delivery, both with spray and dust. With ordinary delivery pipes, 25 feet may be taken as the height dressed, but as the delivery pipes can be made any length, a much greater height can be reached if desired.

The great recommendation of this machine, for the present purpose, is the minute quantity of fluid which can be distributed in a fine dew-like spray; this, so far as experiment shows at present, doing the work we need very thoroughly, and at a low cost, excepting original outlay for the "Strawsonizer" itself.

So far as we see, the hand machine would be the most useful, and it will be very desirable to have reports given, as soon as tried, of its practical workings in spraying infested orchards.*

As the use of Paris-green has only been really taken up on a working scale amongst us during the past season, and the want of proper apparatus has been one great difficulty in our way, I am only able to give observations regarding appliances which have been brought under my notice. The spray *can* be distributed from a common garden engine, but this method involves great loss of material from quite unnecessary quantity of fluid spread abroad, and also great risk of over-application to the leafage.

Whatever kind of sprayer is used, it must always be borne in mind that the mixture must be kept an even strength throughout, and no sediment to form at the bottom, or damage to leafage is sure to happen.

In mixing the Paris-green in the form of dry powder with the water, the method recommended in Prof. Riley's 'Seventh Missouri Report, 1875,' p. 15, is a very simple one, and makes it quite unnecessary to handle the powder. The recipe is given here merely with regard to method of mixing, not with reference to any special proportions:— "Two bucketsful of water are first poured into the can, then three tablespoonsful of good green, well mixed with another half-bucketful of water and strained through a funnel-shaped strainer . . . the use of which prevents the larger particles of the green from getting into the can and clogging up the sprinkler."

The exact method of mixing, however, is quite immaterial—only

* The address of the manufacturers is Messrs. R. Hornsby & Sons, Spittlegate Iron Works, Grantham, who will give particulars on application.

remembering that the powder should be thoroughly diffused through the water, not allowed to be in lumps; and also the methods are best which allow of the operator mixing without handling the powder (lest it should get into possible cracks or sores on the hands), and also give *no room for the careless and thoughtless inhaling it*. I have myself seen in a store the salesman stirring the mass up with his hand the whole time (until I directed his attention to it) that he was speaking to me. For the above reasons, and also for convenience in mixing, the "paste" form mentioned at p. 98 is preferable to the powder.

Mixture of flour with Paris-green.—At p. 88 of report of our own experiments in the past season, Mr. Masters mentions the serviceableness of the addition of flour to the Paris-green mixture. This addition is advised in the U.S.A. on the high authority of Dr. Lintner,* and also of Dr. Packard †; and the following note by Prof. Riley gives his own views clearly on the subject. Speaking of a mixture of Paris-green in 40 gallons of water, he says:—"It pays to add two or three pounds of flour or starch to the mixture, not only because of the greater adhesiveness which they give to the poison (a very desirable object, especially in wet weather), but because by their colour they help to indicate the quantity that has been distributed." ‡

Still, notwithstanding the above high recommendations, it appears to me open to doubt whether the adhesiveness which makes it a useful addition in some cases might not do harm on the very young leafage amongst which our special work lies.

The success mentioned by Mr. Masters was when the leafage was past its early state; and in the various reports I have studied of the use of Paris-green (especially as a remedy for moth caterpillar attack of a similar nature to our own in Canada), I do not find mention of the admixture of flour. Therefore I would suggest that, before trying this on a large scale, some special experiment should be made.

Where the plan is adopted of mixing flour with the Paris-green, the following method is advised:—To take a large galvanised iron funnel of capacity suited to the work; for filling a 40-gallon barrel a funnel of 13-quart capacity is noted. This funnel has inside it a kind of strainer (described as a "cross-septum") formed of fine wire gauze, such as is used for sieves, and this also has vertical sides and a rim to keep it from rocking on the barrel. The quantity wished of cheap flour is placed in the funnel, and washed through the sieve-like wire gauze by water poured in; thus the flour is finely divided and diffused in the water, and the Paris-green subsequently added and washed

* 'First Annual Report of State Entomologist of New York State,' p. 26.

† "Insecticides," by C. V. Riley, M.A., Ph. D. (extracted from 'Fifth Report of United States Entomological Commission'), p. 33.

‡ 'Bulletin No. 3 of United States Entomological Commission,' p. 57. Washington, 1880.

down in the same way by addition of the rest of the water until the barrel is full. The amount of flour used to a given quantity of water or Paris-green appears not to be very important.

The preceding observations give the main points of our work, that is, the work of the Evesham Fruit Conference Experimental Committee during 1890, carried on with such co-operation as I was myself able to give by information from Government and Official Reports for many years back, of successful methods of operation both in Canada and the United States of America, and aided also by special advice with which we were kindly favoured in our difficulties by Mr. J. Fletcher, the Dominion Entomologist of Canada.

Requirements of space only allow of insertion of a portion of the observations, but a large mass of details are in my hands, from which I shall be happy to give any information, and also may remark that in addition to the great amount of information which has long been, and still continues to be, laid before the public in the Reports of the Dept. of Agriculture of the U.S.A., on the subject of arsenical insecticides, that the increasing attention given to the method of lessening amount of insect ravage is furnishing a large mass both of evidence of their utility and details of methods of application, which may be very serviceably consulted in the reports of the Experiment Stations of the Agricultural Colleges of various of the United States, as of Ohio, Massachusetts, Iowa, &c.

London-purple.—In the past season, some amount of trial was also made of another arsenical insecticide which has long been used in America, known as London-purple. This is an arsenite of lime. A notice of the method of preparation and also analysis of this chemical, by Prof. Collier (then Chemist of the Dept. of Agriculture, U.S.A.), will be found at p. 149 of the 4th Report of the United States Entomological Commission, followed by report of the results of trial of the “purple,” of which a number of barrels had been placed at the disposal of the U.S.A. Government by the liberality of the manufacturers, Messrs. Hemingway & Co., in 1879.

The analysis given is as follows :—

	Per cent.
Rose aniline	12.46
Arsenic acid	43.65
Lime	21.82
Insoluble residue	14.57
Iron oxide	1.16
Water	2.27
Loss	4.07
Total . .	100.00

The “purple” may be used either as a powder dressing, or it may be mixed with water, or water and flour, and sprayed on the trees just

in the same manner as Paris-green, but it is stated that owing to its lightness a far smaller quantity by weight of London-purple will treat a given number of trees than would be required of Paris-green.

One great difficulty in its use in America has been that where it is purchased without due caution, merely as a "waste product" that could be had for six cents a pound, or for cost of carriage, there was liability to such differences in strength as to lead to much mischief where applied without previous testing as to effects.

It is therefore very desirable to purchase direct from the manufacturer (who will furnish analysis) in the case of large quantities, or where only small quantities are needed, such as must necessarily be procured from retail dealers, either to procure a statement of strength (*i. e.* analysis), which could be had by the retail dealer from the manufacturer, or to make careful trial of proportion safe to use, before a general application.

In the note regarding this point with which I am favoured by Messrs. Hemingway & Co., of 60 Mark Lane, London, E.C., who have long been manufacturers and exporters of this chemical, they mention that "four ounces of London-purple (owing to its lightness) will treat the same number of trees as sixteen ounces of Paris-green."

This is a matter to be well borne in mind, and in our present state of knowledge of effects of this chemical in England, careful experiment should always be made by new experimenters as to effects, before spraying on a large scale. Also, in a quotation from Dr. Packard in the recent issue of "Insecticides," at p. 33, referring to London-purple and Paris-green, it is noted:—"As the effect is slow in appearing, impatient parties will be apt to re-poison on the second or third day, and thus put on enough to hurt the plant when the effect does come. Much depends on dryness or wetness of the weather; but good effects may be expected by the third or fourth day."*

Amongst the points in which the London-purple is considered to have advantage over Paris-green is, for one thing, its lower price. Looking at returns in my hands from leading manufacturers, wholesale prices are stated for the green, as at per cwt., at 10d. per lb., for the purple per cwt., at 7d. per lb. This of course I give only as a general guide; purchasers would receive definite information from the manufacturers.

Other desirable points are its greater diffusibility in water, also its greater adhesiveness to the foliage, and also that this "purple" or arsenite of lime is stated not to be so poisonous as the "green" or arsenite of copper, although, like the green, the purple *is a poison*, and is

* 'Insecticides and means of applying them,' &c., by C. V. Riley, M.A., Ph.D. from Fifth Report of U.S. Entomological Commission.

to be treated and used with the precautions and care mentioned at p. 97.

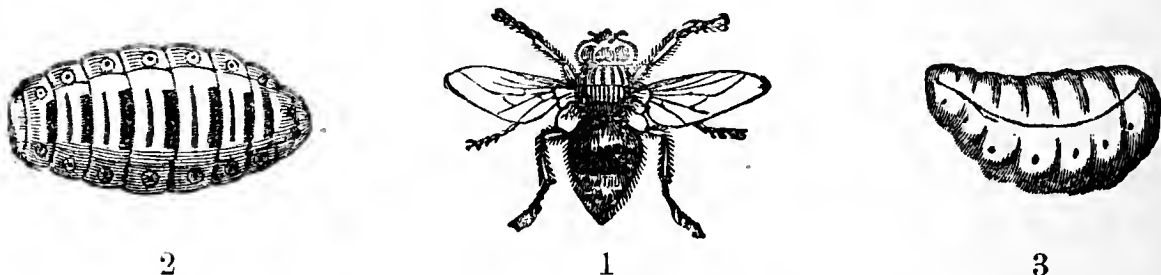
In the above observations I am only speaking of the London-purple in the powder form, used in the same manner as Paris-green powder or paste. Looking at the great mass of evidence attainable in U.S.A. Reports for many years, and other sources, it appears to me that there have been many failures, and sometimes direct injury caused, these failures often to be attributed to the strength of the "purple" being not known, also the operator not having proper apparatus, and also being altogether careless in learning how to apply the spray or to experiment on a tree or so, before proceeding to broadscale work.

On the other hand, there has been such thoroughly good success, showing what *can* be done with proper care, that it would be very desirable for further trial to be made with details duly noted, of strength of powder, proportion used, nature of sprayer with which applied, and results.

Any details which it is in my power to furnish, I shall give with pleasure; and I should fail in courtesy if I did not express my thanks to the heads and managers of the different great firms whose names I have mentioned, for the prompt and courteous attention with which they have uniformly replied to all my enquiries.

O X.

Ox Warble. *Hypoderma bovis*, De Geer.



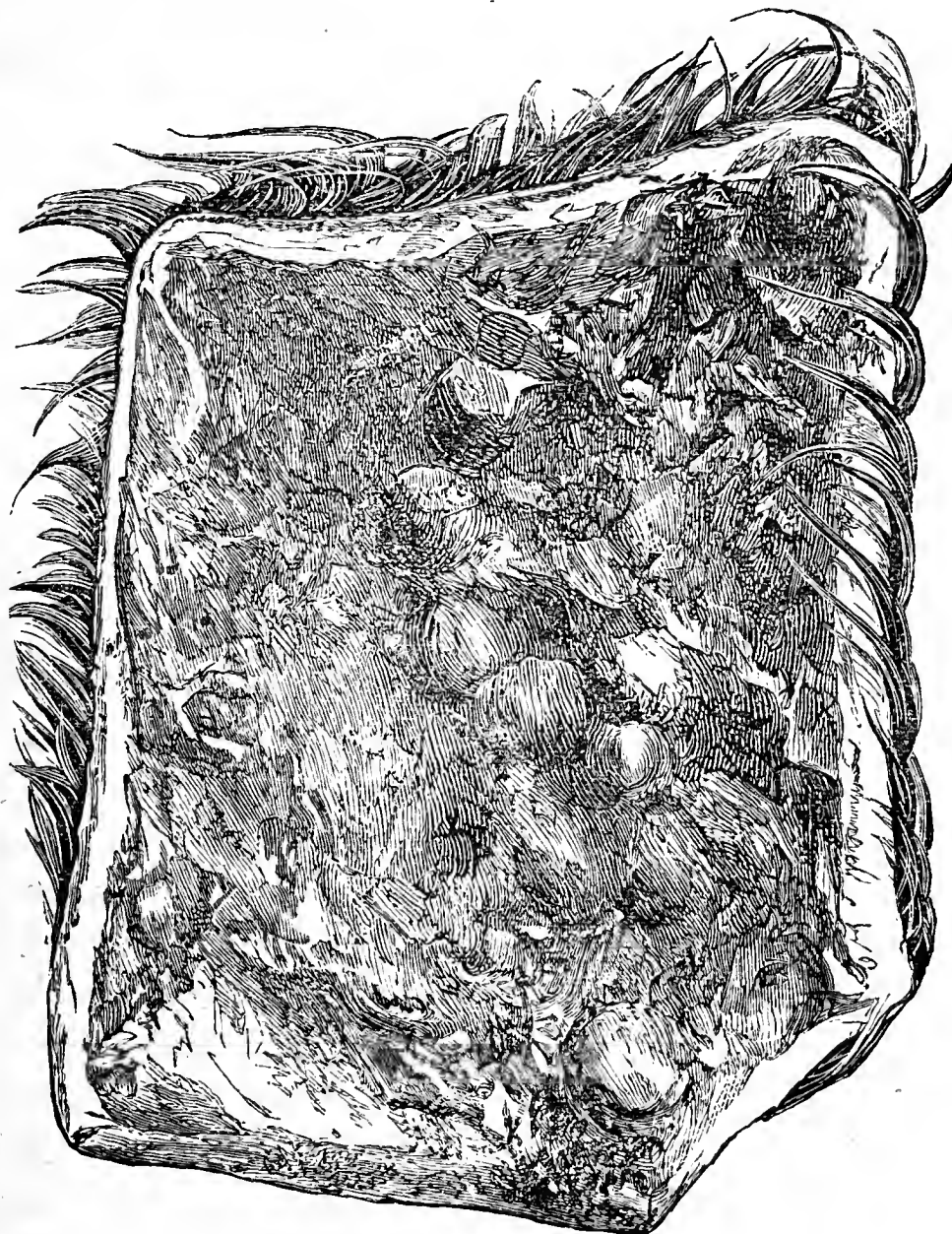
1, Ox Warble Fly; 2, maggot; 3, chrysalis.

During the past year, there has again been much application for information as to the best methods of prevention and remedy of Warble attack; and (also as in previous years) the enormous and perfectly unnecessary loss caused to tanners and hide firms, to butchers and farmers, by this most unnecessary attack, has again been brought strongly forward by those interested. But still the difficulty remains of getting the information home to those immediately interested about the cattle, and to those in out-of-the-way districts, who, having no means of hearing of advance of knowledge of the nature

of the attack, still hold to the beliefs of bygone times as to health bumps, maggots being generated by high feeding, &c.

Very many would be thankful to have the simple information needed in their hands; and though, also, there are many who for sheer idleness, or desire to get a warbled beast sold at the price of a good one, wilfully misrepresent the state of the case, yet with the spread of knowledge the evil could not fail to be lessened; and I should be happy, whether for private use or for distribution, to continue to forward to applicants copies of my leaflets on Warble attack; also on the condition known as "Licked beef" arising from bad Warble presence; and the means found serviceable in lessening these troubles, namely, Warble presence and its consequences.

The following letter with which I was favoured on the 12th of March, by Mr. Chas. Crossland, Treasurer of the Halifax and District Butchers' Association, gives some very suggestive observations on injury to meat from Warble presence, and the "jelly" or slubber accompanying; and the need of more widespread information as to the nature of the infestation.



Piece of under side of warbled hide; Warbles about half size. From a Photo by Messrs. Byrne, Richmond, Surrey.

Mr. Crossland wrote :—" Just now warbled beasts are unfortunately coming plentifully to hand. One of our Halifax firms had 20 beast dressed last week ; out of these no less than 12 were warbled, one of them badly, having about 40 maggots on its loins and crops, or fore chine. This week 8 were dressed for another firm, all of which were affected with this horrid maggot. They were all to pare down, more or less, to rid the beef of the accompanying undesirable jelly. In some cases 1 lb. would clear the beef, in others as much as 4 or 5 lbs., and in bad cases even more than this had to be cut away before a presentable surface could be got at.

" The parings of course had to be thrown into the tallow bag for melting purposes ; this means a loss in money value of 8d. to 9d. per lb., the grub and its concomitant ' slubber ' always affecting the most valuable portions of the carcase. Even the tallow chandler prefers its absence to its presence amongst the rough fat.

" Several of our wholesale carcase dealers purchase foreign cattle at Newcastle ; these appear to be free from Warble, at least I have not noticed any so far.

" Some of the pamphlets received from you were taken direct to the farms of several graziers and feeders, by one of our butchers who purchases most of their stock. He impressed upon them the desirability of using every endeavour to keep down this destructive and pain-producing pest. There was the old notion still held by some of the farmers that the origin of the maggots was spontaneous in the beasts' backs.

" The other day I was talking with a man on the subject, who has been brought up at a farm, and who also has learnt the occupation of slaughterman. Though he had taken off thousands of hides, he had no other idea than the one quoted above, that the grubs originated in the beasts, the lump he compared to ' boils,' and the maggot to the ' knot.' He could scarcely credit the explanation I gave to him of their presence beneath the hide."—(C. C.)

Another communication on the same subject, sent me by Mr. James Barnett, 31 King Street, Ulverston, Clerk to the Ulverston Hide and Skin Auction, together with a request for leaflets as to prevention of attack, shows the extent to which " jelly " may spoil the best part of the beef :—" We slaughtered a bullock last week and I am sure we had quite half a stone of jelly to dress off the back, before it could be sent out ; also a heifer yesterday which had one of the worst warbled backs I ever saw."—(J. B.)

The following note sent me from Nunthorpe Court, York, on the 15th of May, gives another example of the severe injury which is liable to be caused by Warble, and which a very little knowledge of the nature of the attack would show the remedy for at once :—" You may

be interested to hear that a heifer, 3 years old this summer, has been doing very badly; and though I have had two or three tenant farmers who keep cattle on a large scale here to see her, none of them suggested any reason for her not thriving, while the other cattle, Irish beasts, are rapidly getting fat.

“Since reading your pamphlet to-day, I went down again to see her, and notice that she has a mass of Warbles on both sides of her back. I knew she had some, but thought little of the matter; at a rough guess there must be well on for a hundred Warbles. I shall treat her to McDougall’s smear to-morrow.”—(R. F. M. T.)

On the 19th of May I was favoured with the further detail:—“Out of the heifer that I mentioned as doing so badly, we have extracted 65 Warbles, and there are several more still to be exterminated.” “Now that I am alive to the injury they cause, I shall take good care in future to kill them as soon as their presence is recognised.”

The conditions of locality, as exposure, or possibility of shelter in hot sunshine beneath trees or sheds, dry pasture land, or plenty of access to water, make a difference in amount of attack, but these arrangements do not lie, excepting to a small extent, at the disposal of most farmers. A correspondent in Kincardineshire noticed the large amount of Warble presence, which he conjectured was partly caused by the open nature of the pastures merely divided by wire fences.

In the following note with which I was favoured by Prof. John Wrightson, President of the College of Agriculture, Downton, Salisbury, he notes absence of Warble attack under circumstances of the cattle having access to, or being in the neighbourhood of, water, which point (that is, the objection of the fly to crossing water) is specially brought forward by entomological writers.

Prof. Wrightson observed:—“On May 24th I examined most of our dairy of about 27 cows for Warble maggots. Two cows only were affected, and both of them had been purchased into the herd last autumn, and from them I extracted five large larvæ, leaving a considerable number to mature a little further as they would not then come out on pressure applied around the part affected. Although I am not prepared to say there was no Warble on any of our home-bred stock, or upon those which had been here above a year, yet I can say that all those I examined (about 24) were quite free from Warble. I also notice that our cattle do not show any signs of distress in summer, at the season when *Æstrus bovis* is on the wing. I attribute this immunity to the fact that our farm is bounded by the river Avon all along one border of our grazing ground, while open ditches, full of water, traverse the pastures in several directions. A large proportion

of our dairy land is water-meadow, and the valley is literally 'a land of streams'; and this, I expect, is a barrier to the Warble Flies, for I understand that, like the elves and goblins of the highlands of Scotland, 'a running stream they dare na cross.' "

These local circumstances, however (for the most part), can be but little altered or modified, excepting by allowing cattle, so far as may be, access to pools, or to shelter under trees, or in open sheds.

But where the simple remedy of squeezing out the maggots, or getting rid of them by any other way preferred is carried out, *there at once* is demonstrable benefit to the cattle, and when really carried on year after year in a district, it will keep the amount of Warble presence (under ordinary circumstances) well down. I use the words "*really*" and "under ordinary circumstances," because if an application is merely smeared about on the hide, without being sure that *each* Warble hole is properly dressed, or again, if infested cattle are introduced, infestation will not be got under.

In the district round Tarporley (Bunbury, Cheshire), which I have reported since 1886 inclusive,—in which the boys of the Aldersey Grammar School, under the encouragement of their much respected Head Master, Mr. W. Bailey, have yearly cleared the cattle belonging to their fathers or relatives,—the presence of Warble maggots, that is, those counted as destroyed in the report sent me on May 21st, was 827 maggots to 675 head of stock examined. This gives an average of 1 maggot and about a quarter to each animal. This is a very different state of things to that preceding the beginning of our work, when the Warbles were stated to be as plentiful as blackberries; and where, in 1885, one boy alone brought in 250 maggots. The return is from numbers varying from a few, or from one cow up to herds of 102 and 119 animals, and the following observation was sent me accompanying, by Mr. W. Bailey:—

"I am sure it will be gratifying to you to learn that there is no falling off in interest and perseverance in the work which we have on your suggestion taken up.

"You will notice that the boys have examined 675 head of stock (*100 more than last year*), and that after a most persistent search they have discovered 827 maggots, *250 less than last year*, a very decided improvement. In cases where the maggots were not ready for squeezing out they were killed, as in previous years, by applications of the smears prepared by Messrs. McDougall Brothers, and Jeyes' Sanitary Compounds Company, Limited.

"Our experience of past years is confirmed again, namely, that the cattle which have been carefully dressed in one year are free from attack in the next year, and that the pests are found in newly bought stock where no care has been exercised, and in the young cattle

which had not been dressed because they were out in the field.”—
(W. B.)

Where the remedies advised have been tried there has been general success. The names of the leading cattle owners and agriculturists in England, Scotland, and Ireland, whose trial and approval of these I have been permitted to give year after year in my Reports, speak as to the benefit of the treatment suggested both for lessening amount of Warble presence, and also of summer galloping, much better than anything I can say. But still the area over which care and benefit takes place is as nothing to that over which there is none.

Last season's Warble attack (so far as reported to myself) was very bad in home grown hides, also much observed in hides imported from America. Just by way of giving one or two observations on this point, on the 30th of Dec., Messrs. C. H. Hatton, writing from Barton Tannery, Hereford, mentioned, “The cattle were worse than ever this year as regards maggot.”

The following note with which I was favoured from the Bristol and Western Counties Butchers' Hide and Skin Co., by Mr. W. Willis, shows the great amount of damaged hides received:—

“Respecting ‘Warbled Hides,’ I regret to say there is but little, if any, improvement in this district. Whether it arises from the long dry and hot summer we had last year I do not know, but there is scarcely a hide brought into the market that is absolutely free from them, and many of them are as full of them as they can hold.

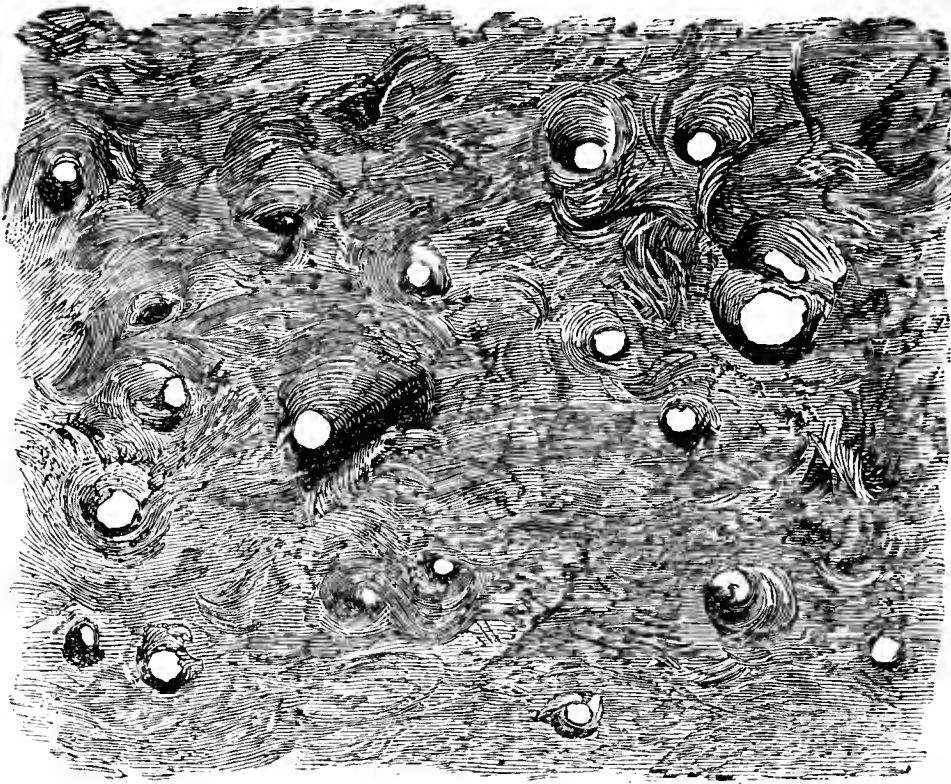
“I may say, too, that the hides we are now getting from the United States are worse in this respect than I have yet seen them. This is especially so with cattle exported from Portland (Maine); during the last two or three weeks there have been a considerable number of bulls sent from there, and most of these had Warbles in them by the hundred, which were of an extremely large size.”

There does not appear to be any use in again, this year, going over from reports the same points that have been given yearly; the matter stands, 1stly, that the attack causes millions of pounds sterling of loss yearly; 2ndly, that it can with certainty and with little expense or trouble be enormously lessened; and 3rdly, that on account of the loss on hides, beef, and return of milk and condition of fattening beasts, it is greatly the desire of Hide Societies, Butchers' Associations, and leading cattle owners and farmers, that the attack should be stamped out.

I know no better way to help this cause than by continuing to spread plain information, and in this matter add the words of the Treasurer of one of our North Country Butchers' Associations as being more forcible than my own:—

“I don't think I can suggest any better reasonable method of dispelling the ignorance of some cattle growers than the distribution of

the leaflets. If the farmers and graziers would only carefully study them, much of the mistiness which appears to envelope the intellects of some of their number in regard to this fly would be cleared away.



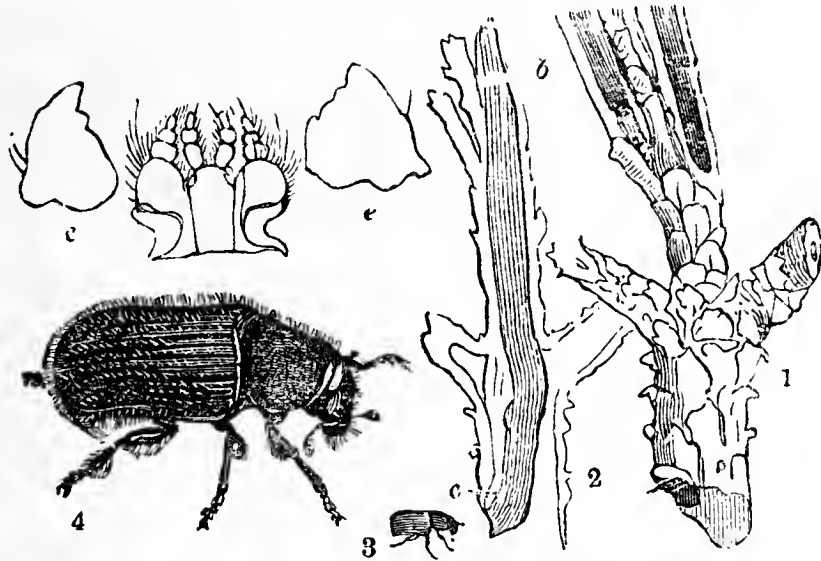
Portion of inside of tanned warbled hide.

“Buyers of their cattle ought never to miss an opportunity of drawing their attention to the leaflet. (Butchers are negligent as well as farmers.) The descriptions of the fly and maggot are so clear, and the remedies so easily procured and so very cheap, that nothing but downright idleness, ignorance or wilful neglect, can account for the prevalence of this fly. If a determined stand was made by all tanners not to buy warbled hides, we butchers would soon turn our faces from beasts with warbled backs and purchase only at a figure allowing for the hide. This kind of thing would best tend to bring negligent feeders to their senses, and cause them to keep a better look-out over their persecuted stock. Of the enormous number of leaflets distributed, very many must have come into hands which have followed the instructions and greatly benefited thereby. But dispelling ignorance of any kind has always been a slow game.”—(C. C.)

The leaflets referred to (namely, one on Warble attack and means of prevention and remedy, and one on “Licked Beef,” both fully illustrated) I shall be happy to continue to send gratuitously to all applicants who desire them for use themselves, or for distribution.

PINE.

Pine Beetle. *Hylurgus* (*Hylesinus*) *piniperda*, L.



1, 2, Pine shoots pierced by beetles, in section; 3, 4, Pine Beetle, nat. size and magnified; *e e*, jaws; *f g*, chin, with feelers, &c.

The following notes are given with reference to observation of the presence of the Pine Beetles for breeding purposes in the Larch.

This beetle has long been known to attack various kinds of Pine, as the Weymouth Pine, and the Silver Fir, and most especially the Scotch Fir, to which it is often seriously destructive. The life-history is for the mother beetle to tunnel a short gallery beneath the bark (see fig. p. 114), along each side of which she lays her eggs. The legless whitish maggots which hatch from these eggs eat their way onwards in, and partly beneath, the lowest layer of the bark, directing their course away from the mother gallery; each maggot widening its own little tunnel as it proceeds, so as to accommodate its increasing size. At the end of their tunnels the maggots turn to pupæ, and thence to beetles, which pierce their way through the bark and may be expected to appear about July or onwards.

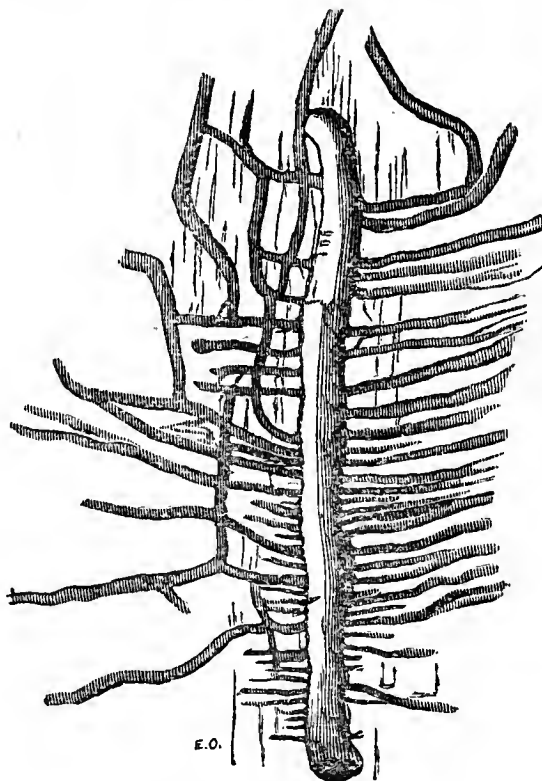
The beetles are of the shape figured above at "3" and (magnified) at "4," of a pitchy colour when mature, rough, punctured, and hairy, and (as shown at "e" magnified) furnished with strong jaws.

The great mischief caused by this attack is from the beetles when developed flying to the growing trees, especially Scotch Fir, and, after piercing into the live shoots, boring a little way along the central pith. Thus the shoot is destroyed and the natural growth of the tree altered, especially where the leading shoot has been attacked. From the pruning or dressings back which they thus inflict on the attacked trees, the beetles take their German name of "Wald-gartner," equivalent to wood or forest gardener.

For breeding purposes the Pine Beetle selects by preference felled or fallen trunks or branches where the sap is not in healthy flow.

Where this is in full vigour the turpentine would run into the freshly eaten out galleries so as to choke and destroy the eggs and maggots.

The life-history has been given at length in previous Reports, but I repeat it again relatively to the exceedingly interesting circumstance



Tunnellings of Pine Beetle.

of the occurrence of this attack to Larch having recently been observed, for the first time on record, in such low latitudes as those of Scotland by Dr. Somerville.*

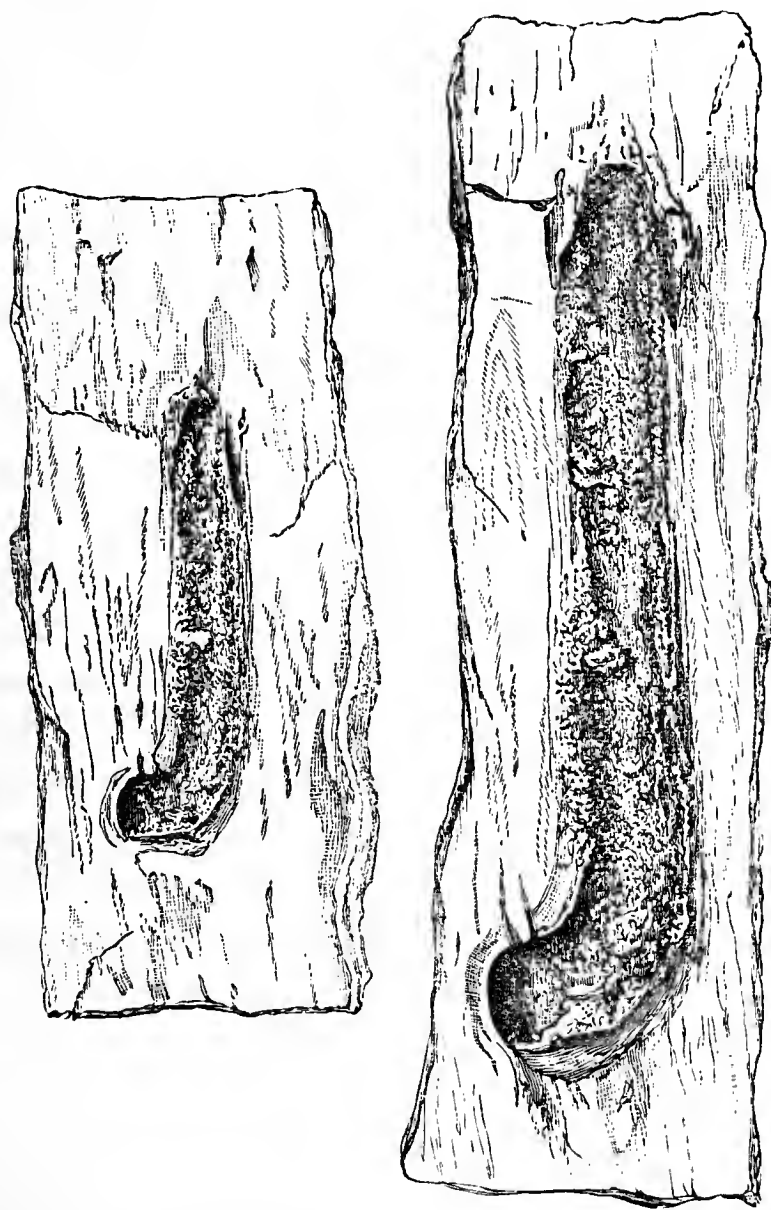
In the course of the past season I was favoured by Dr. William Somerville, Lecturer on Forestry in the University of Edinburgh, with a copy of the paper read by him before the Royal Society of Edinburgh, on July 7th, 1890, containing his personal observations of the workings of *H. piniperda* in his own Larches on the estate of Corniston, in Lanarkshire; and by kind permission of Dr. Somerville I give the following extract from the paper, followed by some further observations with which he favoured me:—

“The special point that I wish to bring before the Society relates to a case of the common Larch being made use of by *Hylesinus piniperda* for purposes of oviposition. As occasion demands, this insect has been found to utilise as a breeding place every species of *Pinus*, but, so far in Europe or North America, no case has been noted of any trees belonging to the genus *Larix* having been similarly attacked. In Asia an observer, namely, Middendorff, has recorded one case which came under his notice in the district of the Boganida, in Siberia, in 71° north latitude (‘Sibirische Reisen,’ Band iv. Theil i. p. 603).

* In the ‘Praktische Insekten Kunde,’ of Dr. E. L. Taschenberg, at p. 205 of pt. II, the writer adds to the mention of various kinds of Pine liable to infestation of this beetle, that it occurs “high up (‘hoch oben’) in the north, even to the Larch.”

“ In the beginning of April of this year, in the Upper Ward of Lanarkshire, on a south-west slope, at an elevation of some 800 feet, I found that several Larches, which had been felled during last winter, were attacked by large numbers of this insect. In its company I also found *Hylastes palliatus*, but by far the greater number of galleries were the work of *Hylesinus piniperda*. During the past three months these trees have been kept under close observation, with the result that I find one or two particulars in which the attack of this insect on the Larch differs from its mode of attacking the Scots Pine.

“ The greater abundance of fluid resinous matter in the Larch, as compared with the Scots Pine, seems to have considerably interfered with the work of forming galleries. I noticed that all the trees lying in the wood were not attacked, but only those at one side, where they were within the shade cast by a dense wood of Pines situated to the south. This I believe to be due to the fact that the cambial activity and formation of resinous solutions were retarded in these trees owing to their not being directly reached by the sun's rays; whereas the cambium and cortex of those trees fully exposed to the sun were so saturated with resin as to be safe from attack. Even in some of the



Mother galleries of *H. piniperda* beneath Larch bark, nat. size and magnified.
From Dr. Somerville's specimens.

trees attacked I found unfinished galleries quite full of resinous secretions, and containing the dead bodies of the male and female insects, which had doubtless been drowned or suffocated by the resinous exudations."*

Dr. Somerville kindly favoured me with a piece of Larch bark containing several good examples of the mother galleries of the Pine Beetle, the *H. piniperda*, one of which I had most carefully figured, so that the wood engraving (p. 115) gives a precise representation of it, both nat. size and magnified. These figures show how the flow of turpentine, now hardened into an irregular coating, has in this instance stopped development of the little maggots, although, if carefully examined, the figure shows a row of little scallopings or niches along the side of the gallery from which, under favourable circumstances, the larval galleries would have been commenced. It will be observed that Dr. Somerville draws attention markedly to the presence of sap in active flow being a powerful agent in prevention of attack, even to the extent of some of the galleries being "quite full of resinous secretions, and containing the dead bodies of the male and female insects." This point of resinous flow demonstrably as well as theoretically stopping attack was of such practical interest, that I wrote further about it to Dr. Somerville, who kindly replied to me (9th Dec.):—

"I delayed answering your letter till I had made another examination of the Larch trees, and I am now able to answer your questions fully. The trees which were attacked by *H. piniperda* were taken possession of by great numbers of this insect, which laid its eggs in little niches as usual; these in due course hatched out, and the larvæ proceeded to eat into the bast, but the resin had proved too much for them, for in no case (at least in no case that I have observed) did they develop into beetles.

"Whether it is possible for this insect to use *Larix* as a breeding place *successfully* or not remains to be shown. Middendorff in his 'Siberische Reisen,' says the Larches were quite full of the galleries of *H. piniperda*, but he does not say whether these were mother or larval galleries."—(W. S.)

These observations appear to me to be very interesting, not only as chronicling a first record of infestation in a new geographical locality, but also as a reason why it is very unlikely to appear in the phase injurious to the living tree. Also it shows us the perfect correctness of the principle we work on to keep the attack of the Pine Beetle, *H. piniperda*, in check on the plantations of Scotch Fir, to which it is mainly (and often very seriously) injurious.

It frequents for breeding purposes felled trees, or broken branches,

* "*Larix europæa* as a breeding place for *Hylesinus piniperda*," by William Somerville, D.Æc., B.Sc. (Read July 7, 1890.)

or (very notably) the choppings of wood with bark on, which are too often left lying about where plantations have been thinned and the poles dressed on the spot. In these, and in similar situations, where there is still sap present, but it is not in sufficient flow to fill the galleries, the beetle makes its breeding tunnels, and the maggots develop to maturity. Therefore removal of all such nurseries, or placing pieces of wood with bark attached to attract the beetles, and clearing away these and destroying them, are amongst the best methods of preventing mischief from this attack to the live Pine shoots.

Excepting where the tunnelling beneath the bark for breeding purposes accelerates the destruction of an already unhealthy tree, this part of the infestation is rarely seriously injurious. It is the boring of the beetles up the centre of the Pine shoots which is the great cause of damage.*

What has been the cause of this heretofore (so far as we are aware) unknown occurrence of attack of *H. piniperda* to Larch in Scotland, we cannot be absolutely sure of. It will be seen, in the following extract, that Dr. Somerville attributes it to the enormous quantity of forest insects which, from special circumstances, were for a while present in the South of Scotland:—

“As to the cause of *H. piniperda* attacking the Larch, I believe a satisfactory reason can be given. About ten years ago the southern counties of Scotland were visited by a succession of exceptionally severe gales, which overturned enormous numbers of Pines and other trees. Partly owing to the glutted state of the market, and partly to the difficulty experienced in dealing with such a large amount of fallen timber, the woods were allowed to remain undisturbed in their devastated condition for a number of years. These dead and dying trees furnished an exceptionally favourable breeding place for *H. piniperda*, which consequently increased at a prodigious rate, each average sized Pine being capable of producing, it is said, as many as 80,000 insects. Within the past year or two the last of this fallen timber has been removed, with the result that the huge army of forest insects, by which the country is over-run, cannot be accommodated with the breeding places which they prefer, and have therefore been compelled to oviposit on what they must consider most unsuitable material.

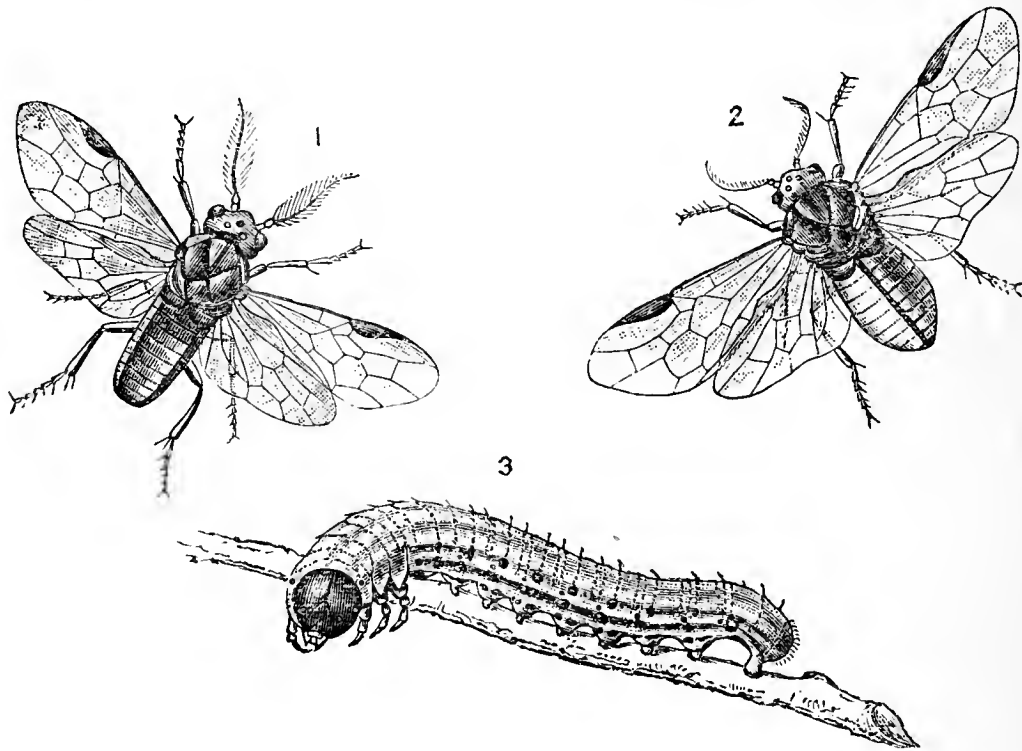
“Thus, owing to stress of circumstances, *H. piniperda* has been driven to attack the Larch, and in this country I have also found Scots Pines, not exceeding eight years of age, infested by it, although hitherto trees of a less age than fifteen years have seldom been known to be attacked.” †

* Observations on methods of prevention and remedy, mainly contributed by Scottish Head Foresters, have been given in previous Reports, and in my ‘Manual of Injurious Insects.’—Ed.

† See paper by Dr. Somerville previously quoted.

I am not able myself to offer any trustworthy opinion on this point of the cause of infestation of the Larch, but no other cause suggests itself. Dr. Somerville, having made both forestry and the Coleoptera his special study, has excellent knowledge of the subject in all its bearing, and has secured to us a valuable as well as interesting observation, in his careful notes of record of presence of the *H. piniperda* in *Larix europæa* in the South of Scotland.

Fox-coloured Pine Sawfly. *Lophyrus rufus*, Klug.



LOPHYRUS RUFUS.*

Fox-coloured Pine Sawflies, 1, male; 2, female, after Prof. Westwood; caterpillar after Dr. Hartig, all much magnified. Nat. size given in descriptions.*

On the 10th of June in the past season, Mr. W. Clark, writing from Stronechreggan, Fort William, N. B., forwarded me specimens of caterpillars as samples of an infestation which was doing much harm to the leafage of young Scotch Fir plantations, over a large area under his management at Conaglen, Ardgour, Argyleshire. On examination these proved to be Sawfly caterpillars, not, however, of the *Lophyrus pini*, the "Common Pine Sawfly" (only too well known for the severe injury often caused by its caterpillars to the leafage and young shoots in Scotch Fir plantations), but of a less frequently observed kind, the *Lophyrus rufus*, or "Fox-coloured Pine Sawfly," so called from the reddish colour of the females.

The above named two kinds of caterpillars are very similar in their

* The above figures of the male and female Sawflies are copied from the very beautiful figures by Prof. Westwood, given on plate xxxv, vol. 7 of 'Illus. of British Entomology,' by J. F. Stephens. The caterpillar is from plate iv of 'Die Blattwespen und Holzwespen,' by Dr. Th. Hartig.

habits, and may be found doing mischief together; and in the following note those that are mentioned as green, which were noticed in 1888, may have been of the "common" kind, but the greenish grey specimens sent to myself in 1890, some of which I reared to the perfect insect, were of the *Lophyrus rufus*. Mr. W. Clark wrote as follows:—

"Here we are very much troubled with a small green caterpillar eating the needles off the young Scotch Firs. In 1888 they were present but in insignificant numbers, but last year, and again this, they are in thousands—I might say millions. They devour all the needles of last year's growth, and till this year did not touch the young shoots of this year's growth at all, but I am sorry to say that this year they *are* eating the young shoots, which must do far more injury to the tree. They begin their ravages about the first of June, and are all away by the end of the month. They are found in large bunches at the end of every twig, having apparently eaten their way outwards. No special part of the tree is attacked first; they can be seen on the highest branches on one tree, and on the lowest on the next, and some trees escape altogether."

A little later, on the 21st of June, Mr. W. Clark further mentioned:—
"I notice that the trees that are well grown, and are, say, about 10 ft. high, are not attacked with the same virulence as small trees from two feet to six feet high. In fact only in rare cases are the larger trees attacked at all, and then only at the very top, the caterpillar appearing principally round two or three last year's growths there.

"Age by no means saves an attack, however, as badly grown trees, ten years old and upwards, may be seen stripped entirely, and those planted at the same time (but on a piece of good ground, well-grown, and perhaps three times as large) entirely free from the pest and in vigorous health.

"For the one case, the last year's growth may be about two inches long, and I notice that said growth is every year, since caterpillar made its appearance in such numbers, growing less; in the other case of the healthy tree, the shoot may be nearly a foot long."—
(Wm. C.)

The caterpillars sent me corresponded in size, colours, and markings, with those of the Fox-coloured Sawfly, the *Lophyrus rufus*, Klug. These are of dusky greenish grey colour variable in depth of tint, with black heads, a fine light line along the back, and a dusky line bordered with a white line above and below, running along each side, in the lowest of which white lines the spiracles are placed. The abdominal sucker feet, and the abdomen below, light green, and like others of the genus *Lophyrus*, these (including claw and sucker feet) are 22-footed. They may be as much as an inch long; my specimens were about five-eighths. "When moderately magnified,

the skin appears wrinkled across and covered with very short stiff black hairs." *

By June 23rd a number of the caterpillars sent had formed their cocoons. These were rather more than a quarter of an inch in length, cylindrical, bluntly obtuse at each end, the colour pale ochrey.† Some of the cocoons were placed on the Pine twigs, and some on the sides of the box, either singly or up to as many as four cocoons together. On the 9th of August (or previously), the imago was appearing, as I then found it alive as well as dead in the box. These Sawflies proved to be of the *L. rufus*, Klug. They are of the shape figured, magnified, at p. 118, and the following description of them is given in Stephens' 'Entomology':—

"Male, with body depressed, somewhat linear shining black; abdomen beneath (except the apex), and the legs, testaceous red; antennæ twice the length of the thorax, sword-shaped with 25 rays on each side, and a simple joint at the apex; wings hyaline, anterior with a faint brownish stigma.

"Female, with the body subcylindric, elongate, and entirely of a testaceous red; antennæ black, 23-jointed, the 2 basal joints testaceous.

"The thorax and the base of the abdomen are occasionally spotted a little with black. Length of body of male $3\frac{1}{2}$, of female 4 lines." ‡

The time of appearance of the perfect insect is noted as from about the end of August to October. Hartig mentions that he bred the Sawflies in the middle of September, from hybernated cocoons (of course of the previous winter) collected from beneath Moss; from caterpillars which fed on the young Fir, and spun up at the end of June, the Sawflies appeared in one instance in the beginning of October, in another at the end of August.

The eggs are stated by Kollar to be laid in the Fir leafage, in the same manner as those of the Common Pine Sawfly. That is, that the female makes a slit with the saw-like ovipositor (from which the Sawflies take their name) along the Pine leaf, and in the narrow hollow she lays the eggs, which she then covers up with a mixture of a tough resinous material and substance scraped from the leaf. From the observations of Hartig, Taschenberg and Kollar, there only appears to be one brood of caterpillars, that which is found on the trees towards

* These caterpillars vary in marking with age and condition, as—whether the caterpillar has lately changed its skin or is about to do so. My specimens varied much, but in essentials agreed with the descriptions of Hartig and Kollar, and may be distinguished by the above notes of colouring from those of the Common Pine Sawfly, noticed in previous Reports.—ED.

† This colour is described by Hartig as "a clear yellow, with more or less of a red tint sometimes appearing through it."—"Die Blattwespen und Holzwespen," von Dr. Th. Hartig, p. 165.

‡ 'Illus. of Brit. Entomology,' by J. F. Stephens, F.L.S., vol. vii. p. 21.

the end of May and in June. Whether this is always so I do not know, but these observations agree precisely with Mr. Clark's, given at p. 119, "They begin their ravages about the first of June, and are all away by the end of the month."

On enquiry as to the position of the cocoons, Mr. Clark wrote me that they were found amongst Moss and Heather, but as far down as it was possible for them to be without being covered with earth.

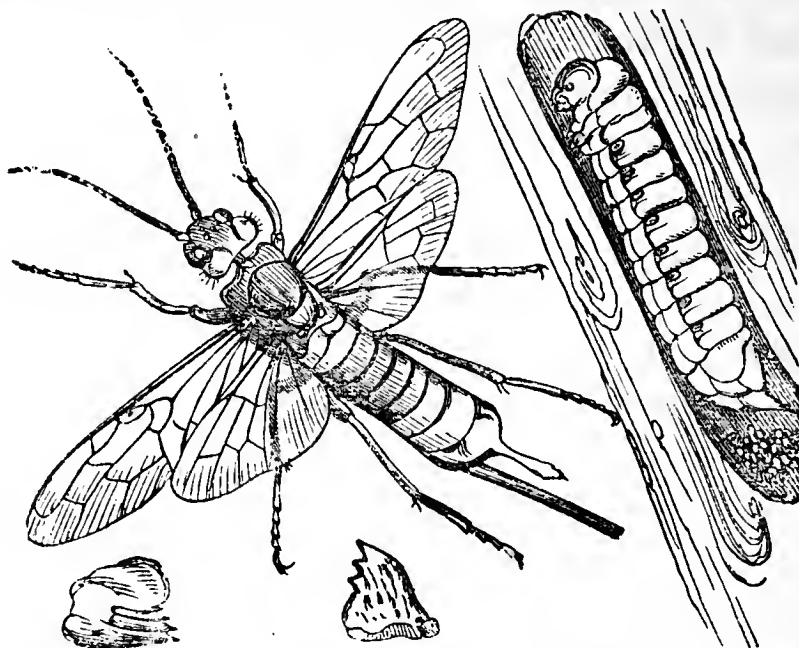
PREVENTION AND REMEDIES.—These are the same which are found serviceable for clearing infestation of the Common Pine Sawfly caterpillars, and which have been mentioned in previous Reports. So far as merely getting rid of the caterpillar has to be considered this may easily be done; but in some cases there is great difficulty in bringing these measures to bear, partly because of the expense that would be entailed in clearing the great extent of plantation infested (in the Argyleshire attack, of which the above notes are given, this was three to four thousand acres), partly also on account of the disturbance to the Heather, in one of the best methods of prevention, lessening its use as a shelter for game.

One of the regular methods of prevention where circumstances allow is, after Pine Sawfly caterpillars have disappeared from the trees on which they have fed, to turn over the surface of the ground beneath, to find whether the little yellowish or brown cocoons, about as large as a small pea, are lying beneath; if so, how deep they lie. Then if desirable they may be collected and destroyed. Where trees are large enough to have (as is often the case with Scotch Fir) little beneath but fallen leaves, rubbish, or small growths, and the extent of wood is moderate, this plan answers well.

Stripping off the caterpillars, by means of a man with a well-gloved hand taking firm hold of the infested shoots and squeezing the caterpillars, has been found to answer. Of this Mr. W. Clark wrote, "I am strongly in favour of hand stripping, as being most effectual, but it takes too much time."

The various methods of prevention of attack, or of remedy when established, which have been found successful on moderate sized tracts of ground, and which are advised by Scottish foresters, have been given in my previous Reports and 'Manual.' *

* Mr. P. Cameron mentions of this species, under the synonym now used, of *L. sertiferus*, "The larvæ are found in May and June; spin up towards the end of June, the flies appearing in August to October, when no doubt the eggs are laid, remaining undeveloped till the following year."—'Mon. of Brit. Phytophagous Hymenoptera,' vol. iii., p. 82.

Giant Sirex, "Wood Wasp." *Sirex gigas*, Linn.

Female "Wood Wasp" and maggot. Jaw of maggot, with four sharp, narrow teeth; and jaw of fly, with three broader teeth, both magnified.

During the past season specimens of *Sirex gigas* have been sent me as doing much harm in Lord Meath's woods, at Kilruddery, Bray, Ireland; likewise by Lady Frances Doyne, from timber at Wells, Gorey, Wexford (also on the east coast of Ireland), and from Mr. Empson Jones, of Woodside, Hacketstown, Carlow, a locality lying some miles further inland between the two above named places.

This insect, which is now well known as injurious to Pine timber in England, was noted in 1850 by Prof. Westwood as being then generally regarded as of very rare occurrence in this country. During the last few years it has been much more noticeable here, but I am not aware of it having been recorded as present in Ireland. The insect and its attack appear to have been previously quite unobserved at the three not very distant localities mentioned, and excited a good deal of well founded uneasiness as to the amount of mischief that might be caused if the infestation spread.

In one of the communications from Woodside, Hacketstown, Mr. Empson Jones mentioned, on the 7th of August:—"I could not see a single male flying about, but saw several females, and the males were far more numerous in the timber three weeks ago than the females. From the quantity of timber destroyed, they must be very numerous this year." *

* The male is easily distinguished by the absence of the ovipositor; the colouring is given in Stephen's 'Entomology' as, "abdomen luteous, the 1st and last segment and its appendage black; the hinder pair of tibiæ and tarsi fuscous, pale at the base." In the specimens of the male sent me, the colouring between the black extremities of the abdomen was of such a reddish tint as to be indistinguishable from that of males of the *Sirex juvencus*, which I have received accompanying their blue-black females. I did not, however, observe any blue tint in the black abdominal markings of these males, nor were any females of the "Steel Blue" Sirex (the *S. juvencus*) sent me.—ED.

Specimens of timber pierced by the great galleries of the grubs, sent me by direction of Lady Frances Doyne, showed great injury, and likewise that the infestation was in condition to extend, for a female "Wood Wasp" was lying almost ready for flight in one of the borings.

Together with the specimens sent me from Hacketstown, by Mr. Empson Jones, he mentioned that the grub bored one-quarter inch holes in Fir trees (which is only too correct a description), and was destroying much valuable timber on his property. He also observed, "Neither I or any person about here have ever seen them before, and if they increase in number will destroy all the timber about here."

From the great size and conspicuous yellow and black colouring of the female (figured life size at p. 122), it could hardly have failed to attract attention if at all numerous; and it would be of interest, both practically and as matter for record, to find whether the attack spreads onwards from the coast.

The history of the method of attack has been given in detail in previous reports. This may be shortly stated to be that the female bores a hole through the bark of various kinds of Fir trees, with her strong ovipositor or egg-laying apparatus, for the deposit of her eggs. This apparatus, see figure at p. 122, is a long fine process appended beneath the abdomen; the abdomen itself ends in a strong blunt point. The maggots are whitish and fleshy, and with their strong jaws eat their way onwards in the solid deal or Fir timber, causing thereby such galleries as quite to ruin it for working purposes. They are said to be full grown in about seven weeks. The change to chrysalis and complete state takes place within the tree, but though the "Wood Wasp" may be fully developed and come out in a month from the change to the chrysalis state, this may very possibly not occur until the following summer, or may be still further delayed as in many other cases of wood attack.

The infestation has been considered chiefly to affect trees in which the sap is not in full flow either from age, or from accidents to the branches or other part attacked, or especially to affect felled or fallen timber or branches.

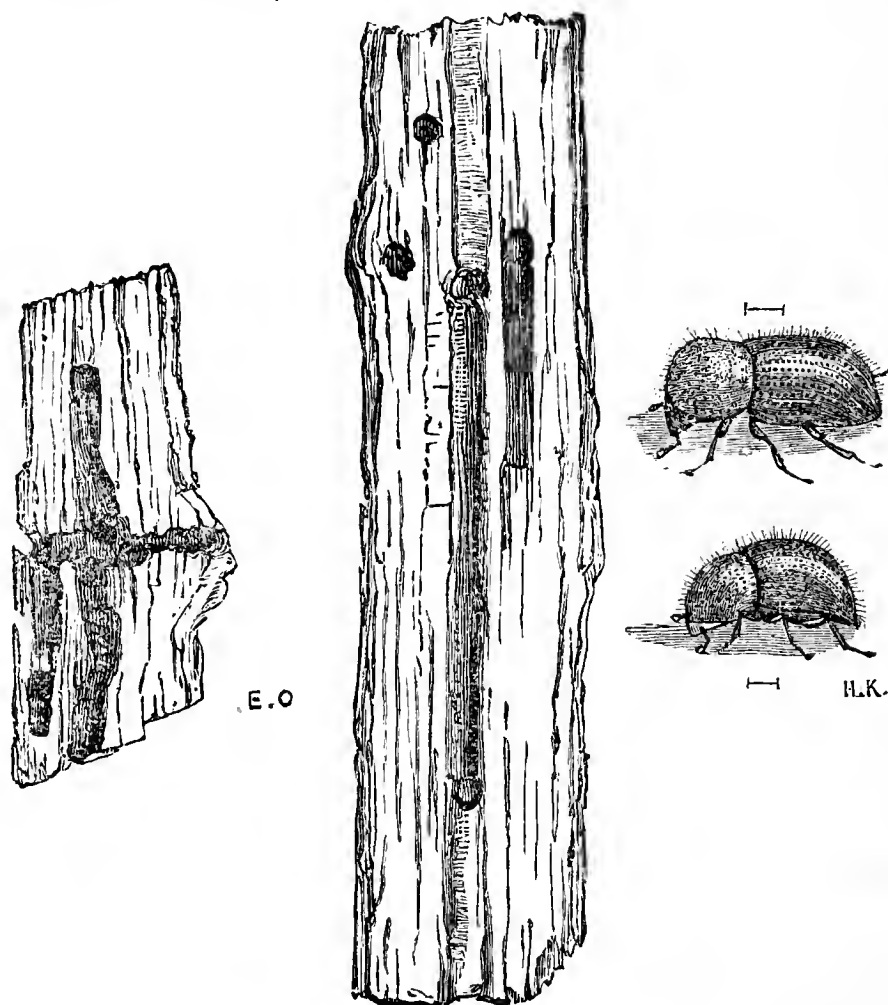
Where the insects, as is sometimes the case, are seen coming out in numbers in the course of a few hours from a felled trunk, it is well worth while to set some one with a hand net to catch such as may endeavour to fly away, or to destroy them as they make their appearance.

Splitting up felled timber known to be infested, and using it for firewood or otherwise, so as to prevent any chance of insects spreading from it, and similar attention to injured or fallen trees or branches in Fir woods, are the best (and apparently the only) methods which lie

in our power of checking spread of this attack. This infestation appears to merit attention, for it is being increasingly reported. In 1850 (as quoted p. 122) it was considered as of rare occurrence, and it has gradually been more observable, until, as at present or in the last few years, I have notes and specimens of infestation, of both *S. gigas* and *S. juvenus* (the Steel Blue Sirex), occurring in standing timber to an extent to cause definitely calculable loss.

PLUM.

“Shot Borer.” “Apple-bark Beetle.” “Pear Blight.” *Xyleborus dispar*, Fab.; *Bostrichus dispar*, Fab.; *Xyleborus pyri*, Peck (of American writers).



Xyleborus dispar: Male and female beetle, magnified; lines showing nat. length. Plum stems, showing horizontal and perpendicular galleries.

It will be remembered that in 1889 a small dark brown beetle (figured magnified above with the natural length marked accompanying), which had previously been considered to be one of our rarest kinds, made its appearance in stems of Plums at the Toddington Fruit Grounds, and a few other localities not far off, in such numbers as to cause considerable injury.

The mischief is caused by the beetles so tunnelling the trees as to

stop the course of the sap; and consequently the destruction of the small trees (which are preferred for boring purposes by the beetle) is rapid and complete. Full details were given in my preceding Report.

But it may be desirable to repeat that the reason of the singularly rapid and complete destruction of the stem of *young* trees attacked by these beetles was plainly shown on laying open their tunnels. In the specimens of these from Toddington which I examined (figured life size at p. 124), I found that the injury began by a small hole like a shot-hole being bored in the side of the attacked stem, from which a tunnel ran to the pith, and a branch about the eighth of an inch across ran horizontally about half or two-thirds round the stem. Sometimes this tunnel was about midway between the outside and the centre, but in one instance quite at the outside of the wood. From these horizontal borings, other borings were taken straight up and down the stem; these might be certainly as many as four (perhaps more in one stem), and were from half an inch to upwards of an inch and a half long; and of these tunnels (in the pieces of stem I examined) one ran along the pith, which was completely cleared away. The great injury caused by these galleries fully accounted for the death of the stem.

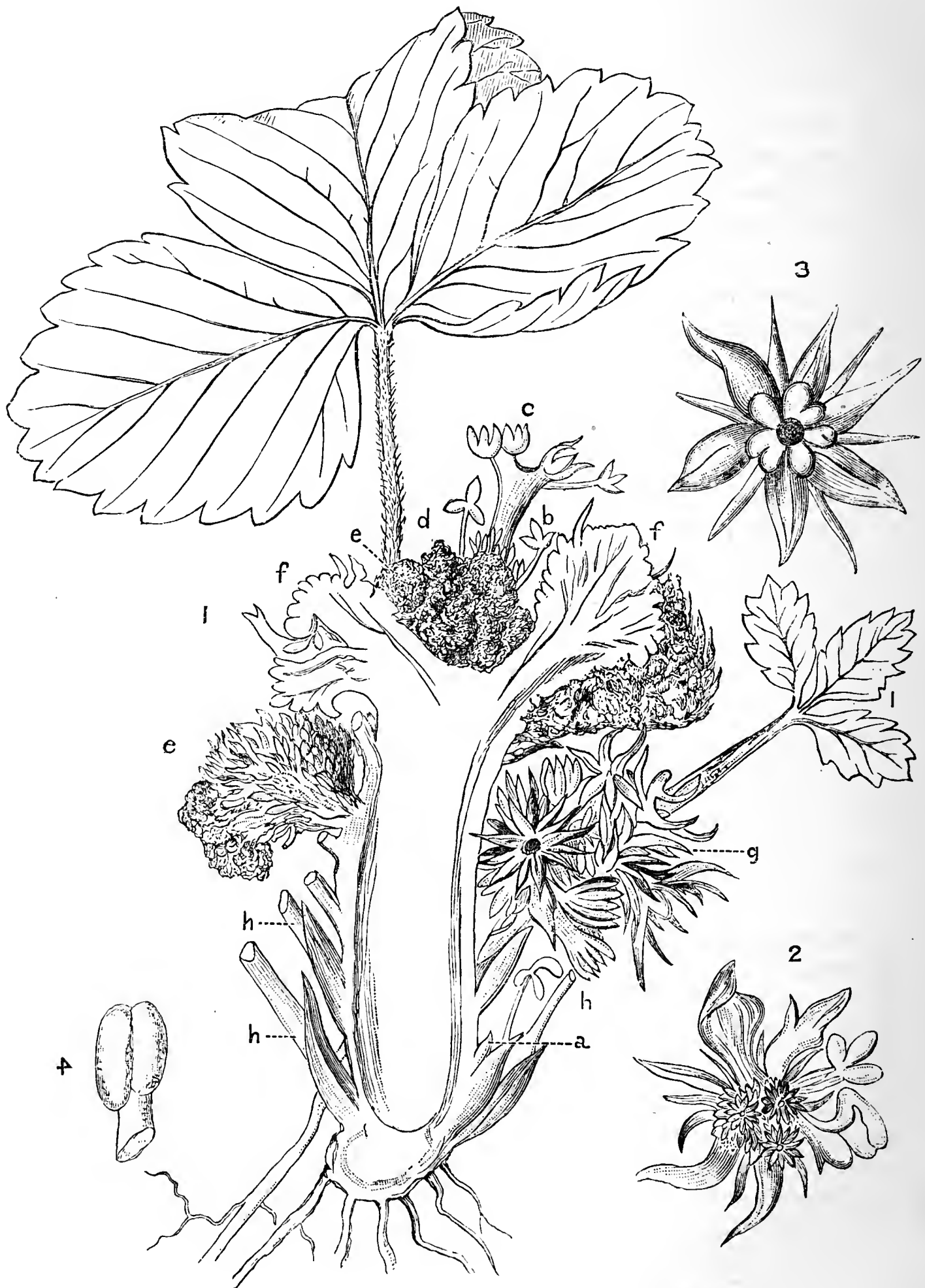
The great peculiarity of these insects is the difference in shape and size between the male and female (the *disparity*, from which the beetle takes its name of *dispar*). The female is about the eighth of an inch long, narrow and cylindrical, with the thorax (the fore body) large in proportion, and raised in the middle so as to make a kind of hump. The male is only about two-thirds of the length of the female, and much wider in proportion, and the back is flatter.

As a method of prevention, cutting down the attacked trees and burning them when the infestation is noticable is most strongly to be recommended. It is no waste, for in many cases the attack is completely and rapidly fatal, and if the plan is carried out before the female beetles (which may be found in such numbers as almost to fill the galleries towards the end of summer or autumn) have flown, it is very effectual.

In the case of the attack of this *Xyleborus dispar*, or Shot Borer Beetle, at Toddington, all the trees that were found to be affected were cut down and burnt; and this year Mr. C. D. Wise, the manager of the Toddington Fruit Grounds, notes that only one case of attack has been found.

STRAWBERRY.

"Cauliflower Disease." *Aphelenchus fragariæ*, Ritz. Bos.



Strawberry plant diseased by infestation of *Aphelenchus fragariæ*, after drawing by Dr. J. Ritzema Bos,

DESCRIPTION OF FIGURES.

1. Strawberry plant infested by *Aphelenchus fragariæ*.
 - a. Scaly buds developed in the axils of normally developed leaves—*h*.
 - b. A very swollen stem, with
 - c. Rudimentary flower buds always remaining closed.
 - d. Accumulation of rudimentary buds at the base of the branch *b*.
 - e. Cauliflower-like accumulation of strongly branched and broadened inflorescent parts, with imperfectly developed flowers and sheathing-leaves.
 - f. Section of similar Cauliflower growth.
 - g. Accumulated blossoms, partly rudimentary, partly abnormally, developed, such as are shown separately in 2 and 3.
 - h. Portion of leaf stalks of normally developed leaves.
 - i. Stunted leaves of fairly normal shape.
2. Monstrously developed blossom; outer leaves of the calyx narrow; inner calyx leaves more developed, some very thick and twisted, others branched, and a few trifold like ordinary leaves; the blossom appears to have split into three divisions, but the petals, stamens, and pistil of these parts have remained rudimentary and indistinguishable from each other.
3. Monstrously developed blossom; outer leaves of the calyx narrow; inner leaves of calyx well-developed, but a few of them twisted; petals of corolla stunted, and some of them twisted, and no sign of pistil or stamens.
4. Abnormally developed stamen.

The figures opposite, are copied, by permission of Dr. J. Ritzema Bos, from a portion of the illustrations given in his paper on "The Cauliflower Disease of the Strawberry, caused by *Aphelenchus fragariæ*, nov. spec.," entitled "De Bloemkool-ziekte der Aardbeien, veroorzaakt door *Aphelenchus fragariæ*, nov. spec.," door J. Ritzema Bos (voorloopige mededeling). Overgedrukt uit het Maanblad voor Natuurwefenschappen, No. 7, Jaargang, 1889.

In availing myself of the courteous permission of Dr. Ritzema Bos to extract from his pamphlet, it is but right to mention that with the accompanying figures I have only inserted a portion of the elaborate numberings and details given in the original paper. As my report is for general use, these minutely scientific details would be out of place here; but in extracting from his work I am bound to mention the elaborate minuteness of the paper from which I give some main points.

The following observations refer to peculiar malformations of growth, caused by Eelworm presence, so affecting the stems and inflorescence of the Strawberry plant as quite to change the characteristic appearance of the growing portions of the plant, when it should be running on into flower, and ruining it for all useful purposes.

From the buds (or the various portions which should have formed the buds and flowering stems) being so greatly swelled at the extremities, and also so shortened and pressed together as to resemble nothing so much as pieces of Cauliflower placed amongst the deformed stems, it has seemed convenient to give the name of the "Cauliflower disease" to this form of Strawberry attack, in the same way that "Tulip-root," "Pine Apple disease," or other names describing the shape of diseased growth, are given to the malformations caused by the presence of the minute nematoid worms, popularly known as Eelworms, in Oat plants, Carnations, and other garden or crop plants.

The first observations of this very peculiar attack which I received, were sent me by Mr. Thos. May, of St. Paul's Cray, Kent, on the 23rd of May, and were as follows:—"I have forwarded you to-day a hat-box containing specimens of Strawberry plants from a field of 14 acres; nearly half the plants have gone like these specimens. Will you please say whether caused by an insect or grub injuring the crown just above the roots" "Whether there is a remedy or prevention, and whether the plants will recover, as some seem likely to do, for another year?"

These plants were greatly deformed, and I found Eelworms therein. On the 28th of May a further supply of diseased Strawberry plants were sent me, in which I found Eelworms in exceedingly active condition, numerous present where I examined, and (together with the specimens) I received from Mr. Thos. May some further observations as to loss being serious, and likewise as to previous succession of crops, as follows:—"I trust you will be able to ascertain the cause, as it will be a serious loss to me this year in the 14-acre field. Now, in reply to your questions, the field has been cropped as follows:—

"CROP.		MANURE.
1881 to 1884.	Strawberries - - -
1885.	Potatoes - - - - -	{ Heavily manured with London straw dung, and some kainite suppl. ammonia, superphosphate, sown with Potatoes.
1886.	Wheat - - - - -
1887.	Clover, very heavy crop - -
1888.	Potatoes - - - - -	{ Heavily manured (again as before) in winter of 1887-8.
1889.	{ Planted Strawberries and plants, all started well and did well.	{ 1889-90. Manured Strawberries in November and December, and dug in peat Moss and sawdust horse manure from London, having laid in lumps from August."
1890.	{ Strawberries with large quantity of deformed plants.	

On June 3rd, together with further specimens of Strawberry plants from the same 14-acre field, Mr. May mentioned that half of the plants were affected *equally all over the field*, excepting on a half-acre, where there were Potato clamps before planting, and where they had a large manure-mixen. "These two patches," my correspondent wrote, "look well, all but an odd plant or two here and there, about one in fifty in these two patches; the remainder of the field is just about equal. The plants on half the field came from my own old plants, and the other half from a neighbour's." With regard to the origin of the infestation, Mr. May observed, "I am satisfied it has nothing to do with the plants when put in; they all grew well last season."

In the first specimens of diseased Strawberry plants sent me I found some Eelworms, and in a further supply sent me on the 28th of May, on opening one of the side buds and tearing it small under water, I at once found Eelworms of various sizes numerous present; these Nematodes appeared to me to be longer in proportion to their width than is the case with the *Tylenchus devastatrix*, which infests so many of our plants or crops, notably Oats and Clover. Not, however, having the requisite knowledge of nematoid worms to identify the species trustworthily, I forwarded infested plants to Dr. J. Ritzema Bos, Professor at the State Agricultural College, Wageningen, Netherlands, for the benefit of his well-qualified opinion. On examination Dr. Ritzema Bos found the infesting Eelworms to belong to the genus *Aphelenchus* of Bastian, but not to be identical with any of the species of this genus with which we were previously acquainted, and therefore, as being previously undescribed, he has bestowed the name on it (in his "Preliminary Paper" descriptive of the Nematode and its attacks) of the *Aphelenchus fragariæ*.

The much magnified figures of *Tylenchus devastatrix*, on the plate facing p. 48, may be taken as giving a general idea of the shape of *Aphelenchi*, inasmuch as in both cases these are "long eel-shaped *Anguillulidæ* with a flexible ringed skin"; in both cases also there is a "spear" or "stilet" in the mouth-cavity or gullet. There are, however, essential differences in structure, which, as they can only be observed with the help of very high microscopic powers, I do not enter on here, but by permission of Dr. Ritzema Bos, who is good enough to allow me to extract at pleasure from his paper, of which the title is given at page 127, I offer just a few notes from his measurements, &c., and likewise his valuable botanical description of the effect of the infestation on the plant growth, as giving this with a technical precision beyond my own powers. I have also added from the plate of *A. fragariæ* and the malformed growths caused by it, given in his pamphlet, a portion of the figure of the different forms of injury the infestation causes to different portions of the plant, drawn by him from life.

Dr. Ritzema Bos observes that "this *Aphelenchus fragariæ* is a small species" (the greatest length of such small amount of males and females as occurred in the plants I sent was found by him to be, of males, 0·85 mm.; of females, 0·80 mm.—ED.). "The stilet is small; in one specimen I decided it to be 0·0094 mm. long. Although this organ is at first sharp and thin, it ends in a blunt knob-shaped swelling.* The gullet was indistinct in the specimens I examined; it seemed to be rather twisted. The sucking stomach is oval; there the intestine begins, at first very narrow, afterwards broader. Its wall is finely granulated." Details are given of male and female characteristics, so far as observable; but though larvæ were plentiful in the plants I forwarded in May and June, yet Dr. Ritzema Bos noted with regard to the males and females:—"I did not observe one of either sex which was perfectly mature, containing developed spermatozoa or eggs on the point of being laid. It seems from this as though reproduction only takes place during the latter part of summer."—(J. R. B.)

The following extract describes the effect of the infestation on various parts of the plant, as the stems, buds, flower petals, calyx, &c., and being favoured with permission so to do, I give it in the words of Dr. Ritzema Bos rather than my own, as being clearer and much more technically precise than any wording I could myself have offered.

*Description of the effects of the infestation on the growth of the
Strawberry plant.*

"In the axils of the normally developed lower leaves (see Plate, fig. 1, *h*) numerous thick scaly buds appear, much like the little scales that form on a bulb; these buds never grow new stolons. Sometimes the main stem grows fairly tall to begin with (probably because the plant was not attacked by a large number of *Aphelenchus* at once), but a certain height being attained, it branches very vigorously, and the branches are not only thick and broad, but remain united as they grow, so that there is actual fasciation. There is, however, no ribbon-like broadening, but a thickening, which can be best compared to a piece of Cauliflower; therefore I have indicated the disease caused by *Aphelenchus fragariæ* as 'Cauliflower disease of Strawberry plants.'

"In a few cases a simple ribbon-like broadening of the stalk takes place, and the numerous flower and leaf buds that result are more or less normally developed. Sometimes one side of the stalk or branch grows and fasciates more strongly than the other side; the stem then

* If the reader will turn to Plate of *T. devastatrix*, he will see a spear or stilet with knob-shaped base figured at "a" in 1 and 4, which gives an idea of the form of this mouth part, but with the difference that in the *Tylenchus* this knob is trilobed.

bends, and may even become quite twisted up. Some stems split at the top of the fasciation into a number of different branches, with more or less normal flowers and leaves. Most commonly, however, the stalk or branch gets scarcely broader, but much thicker; the side branches remain in great part fixed together, and it is an exception for the buds to be perfectly developed. The deformed plant greatly resembles Cauliflower or Brocoli, according as the different parts are more or less enlarged and attacked, and according as the buds are not at all or only partially developed, or have produced malformed flowers. Some very broad and stunted stalks have buds on the top, pressed together like a cock's comb; and some have them at the sides, spread very irregularly, in consequence of the irregular growth, but growing thickly squeezed together over a large surface.

"Usually, as in Cauliflower, one finds buds almost all over the squeezed-up mass of malformed parts. The likeness to Cauliflower is especially strong, as is shown at *e*, fig. 1, of accompanying Plate. Similar Cauliflower-like parts are shown, in section, at *f*.*

"If all the branches of the abnormally branched parts remain short and pressed close together, they take the appearance of common Cauliflower; but if the flowering stems get more slender, and are not joined together all the way up, then the likeness to Brocoli† becomes strong. The branches are generally all more or less enlarged (fig. 1, *b*), though a few of them may develop normally; some of the leaves may be normal, but many remain very small, and the leaf smaller in proportion than the stem; sometimes instead of being trifid it is entire, and some are much twisted.

"The sheathing leaves are mostly small, or thick and irregularly twisted. The flower buds are sometimes very thick, while the leafy parts remain thin and scaly; sometimes the leafy parts become much thicker, but remain short, and continue to produce little scales. Often the outer calyx, and calyx, are more developed than the other leafy parts. Sometimes the bud remains entirely or in part closed (*c*), while the outer calyx, and calyx, go on developing normally; but often the flower bud opens.

"The leaves of calyx and outer calyx are frequently abnormal, those of the outer calyx being very thin and narrow, almost needle-

* 'On the Structure of the Cauliflower.' Compare Samsøe Lund, 'Hjalmar Kjaerskou Morphologisk-anatomisk Beskrivelse': *Brassica oleracea*, L., *Brassica campestris*, L., and *Brassica napus*, L. (Havekaal, Rybs or Raps), Copenhagen, 1885, pp. 52—54. See also the figures in same work, Plate 10, and compare with fig. 1 of my Plate, *e* and *f*. Compare also the illustrations in * 'Om Landbrugets Kulturplanter og dertil hørende froavl.' No. 4. Beretning om virksomheden i. aarene 1882—3, ved. E. Rostrup, Copenhagen, 1884.

† Especially to the Brocoli described in note (1) of the latter work, p. 151, fig. 52.

* 'Our Cultivated Plants and their Diseases' (Danish).

shaped; while the calyx leaves, on the contrary, develop more strongly; occasionally they are twisted, and have bubble-like swellings on the under-side. Some are more or less cut into; others are trifid, imitating the normal leaf (see calyx leaves, figs. 2 & 3). The corona petals sometimes do not develop at all; often they remain rudimentary; sometimes (fig. 3) they are much smaller than the divisions of the calyx, and twist to and fro, generally towards the inside; then they are not white, but greenish white or very light green, though thin and delicate in texture as usual.

“The stamens are wanting in many of the flowers, or are represented by such rudimentary growths that their real nature cannot be recognised; in others, which have a normal anther, the filament is much thicker and shorter than in the case of normal stamens. The receptacle and pistil are often very small (fig. 3); sometimes the latter is altogether absent. Sometimes there is an axillary prolificacy of bloom; this always seems to be caused by new buds forming in the axils of some of the calyx leaves.* But these buds never make normal flowers (fig. 2); in the place of where they might have been we find a number of leafy organs, nearly rudimentary, sometimes forming little knobs.†

“It is hardly necessary to add that stems, leaves, and blossoms of fairly normal development may be found on plants that are only slightly attacked by the disease.”

In the foregoing extracts I have availed myself gratefully of the permission of Dr. Ritzema Bos to make use of the descriptions given in his paper, as, indeed, without so doing I could only have laid an excessively meagre account before the reader, without details of the nematoid cause of the infestation. But, whilst limiting myself to such extracts as may be of general interest, I should be to blame in not mentioning that these give no idea of the minutely detailed observations given by the author, nor of the amount of valuable information contained in his note-references to published works where descriptions of the various species of *Aphelenchus* already recorded may be found, and other points of scientific interest. The paper is headed as a “preliminary” one by the author, as he desires to add further points from the coming season’s observations.

We are still without knowledge as to where the infestation came from, and also we do not know what remedial applications may be of service in checking the diseased growths, because these were already fully developed when the attack was first brought under my notice

* “According to Maxwell T. Masters (*‘Teratology of Plants,’* translated into German by Udo Dammer, Leipzig, 1886), new buds are formed in the axils of calyx leaves more frequently than in those of the other leafy organs of the flower.”

† In the original paper many references are given.

towards the end of May, 1889. Then it appeared to me that as the plants sent were masses of infested malformed growth, the best suggestion I could give was to destroy them as rapidly and as thoroughly as could be done, so as (if possible) to stamp out the Eelworm presence.

The only clue that, so far as I see, we have at present, towards checking this special form of attack, lies in the circumstance of scarcely any of it (perhaps one plant in fifty) being observed on the spots where, respectively, a manure heap and also Potato clamps, occupying about half an acre, had been. These spots were dressed with the same peat-moss, &c., manure, and in the same proportion as the rest of the field; so this shuts the door on the probability of the infestation being brought in the manure, which suggested itself. But it certainly points to difference in state of surface soil affecting amount of attack. Whether the plants thrived and did better on these spots, and so resisted attack better, or whether the Eelworms which might be present were buried and killed, is at present unknown; but still we may get some practical help towards prevention from the above observation.

With the coming season it will be possible to try, with the first plant growth, whether the applications of sulphate of ammonia, sulphate of potash, &c., mentioned at p. 20, which have been found serviceable in other cases of Eelworm attack to other kinds of plants, may not be serviceable in this case also.

TARES.

Tare Weevil. *Apion pomonæ*, Fab.

1, Distorted flower head of *V. sativa* infested by the "Weevil"; 2, seed pod showing injuries inflicted by it; 3 and 4, "Weevil," *A. pomonæ*, nat. size and magnified.

On the 15th of July in the past season the following communication was sent to me, with specimens of the infestation accompanying, by Mr. A. Hamlin, of Chellowes Park, Lingfield, Surrey:—"I herewith forward you a few heads of Tares, infested with maggot, taken from an eight-acre piece, the whole of which is equally bad. As this is a very common pest in this neighbourhood, recurring rather frequently, I thought perhaps you might know its natural history, and probably be in a position to recommend a remedy, so that we might endeavour to lessen or exterminate it."

The heads of the Tares were variously affected by the attack. In some instances a portion of the blossoms had expanded, or were expanding, apparently quite rightly, but just beyond them the buds were stunted so as to form nothing but a terminal deformed bunch composed of stunted calyces, with sometimes minute embryos of flower and ovary within, sometimes some minute stunted leaves mixed with them. These deformed flowers varied very much in size, and whereas the calyces of the healthy blossoms were over half an inch in length, those forming the diseased bunches were often from about a quarter down to only about an eighth of an inch in length.

In some instances these masses were chiefly green, but often they were brown, and injured towards the middle of the bunch. Each individual floret (or rather what would have been the floret, if it had not been attacked) was usually swelled at the base into a shape like a little bulb, with the calyx tips surmounting it like minute feathers.

Besides the injury to the buds, I found much deformity caused to the leaves. The lower part of the leaf stalk was greatly swelled (to five or six times its natural width), and, instead of standing out at an acute angle from the stem, was often curved backwards, so as partly to encircle it, or turned downwards. The leaflets were sometimes merely placed somewhat nearer together than was natural, sometimes so closely that the two sides of each leaflet were pressed together, and against those on each side along the leaf stem, like the flattened fingers of a glove. The heads were also somewhat turned down, and when the leaf stems near were also swelled, the deformed condition was very noticeable.

The magnified figure, at p. 137, of one of the diseased heads shows the stunted florets massed together, with a number of the partially unfolded leaflets pressed almost against each other, and growing from a much swelled and distorted leaf stalk. I had not, however, the opportunity of making out with any degree of certainty the kind of insect which caused the attack. So far as I can make out by insect presence, or by description, it *might* be caused by a *Cecidomyia*, or by the *Apion pomonæ*, one of the Clover weevils, or by both. If any reader, either from personal observation or from better entomological knowledge, should have traced the attack to its cause, it would be of very serviceable interest if he would be good enough to let us know.

In the heads of Tares sent me on the 15th of July, and somewhat later on, I found larvæ of some kind of *Cecidomyia*, or Gnat Midge (little maggots resembling the well-known Red Maggot of Wheat in shape and size), with the anchor process very plainly to be seen under a one-inch object glass. The largest specimens were of a rather pale orange colour, the smallest, up to about half-grown, white or whitish. The "anchor process," that is, the kind of horny scraper lying beneath the body at the head end, was distinctly bifid at the free extremity, though not so deeply cut in as in that of the *Cecidomyia leguminicola* (the American Clover-seed Midge), figured at p. 23. The position of the scraper will be seen from the "Red Maggot," figured at 2 on the same page. The maggots were somewhat numerous* in the heads first examined. Later on, that is, on the 28th of July, Mr. Hamlin wrote:—"It may be of interest to you to know that I had considerable difficulty in finding heads containing the maggots to send you on the

* There were also some Thrips present, almost entirely of a bright yellow colour, excepting towards the extremity of the tail, which was black.

second occasion, though the first time I sent them, which was but a few days previously, I had about an equal difficulty to find them free." This observation points to the maggots going down into the earth for their changes; and also, Mr. Hamlin observed, when some of the Tare heads were laid on earth, that these (and other maggots from the heads) went down into the soil. Mr. Hamlin also remarked "that the infestation started from the hedgerows."

In Curtis' 'Farm Insects,' at p. 487, the author observes, under the head of Tares:—"In July the flower heads are often distinctly distorted, and on opening them numbers of maggots are found concealed in and amongst the calyces, or cups of the flowers, where they eat into the base, and entirely consume the incipient pod. These little larvæ are 1 line long, of an orange colour, tapering to the head, and blunt at the tail. In all probability they are the offspring of some species of *Cecidomyia* allied to the Wheat Midge."

Turning now to the short notes given by Bergenstamm and Paul Löw of various species of *Cecidomyia* of which the method of life of the larvæ is known, but of which the perfect insects (up to date of publication) were still unknown and undescribed, I find four kinds recorded as (respectively) causing deformed growth of the inflorescence, the leaves, or the shoots of various species of Vetch, one of these being the *Vicia sativa*, the Tare. Of one kind it is noted (No. 597, p. 98), "The larvæ live in deformed blossoms of *Vicia sativa* and *cracca*, L.," and the suggestion is added that perhaps it is identical with the *Diplosis loti*, Deg. As neither Mr. Hamlin nor myself succeeded in rearing the perfect Gnat Midge from our *Cecidomyia* maggots, we cannot at present form any opinion as to the species of these larvæ.

The above infestation may prove (when we can procure full details) to be the cause of part of the mischief; but there was another kind reported to be sometimes present, which probably had to do with the matter, thus noticed by Mr. Hamlin:—"We are also troubled occasionally with a maggot that is found in the Tare pods, which develops into what we term 'a bug' with wings, having a sharp snout 'similar to a mole.'" This short description corresponds, so far as it goes, with that given by Curtis of the attack of the *Apion pomonæ*, one of the long-snouted weevils, figured at p. 134.

Of this John Curtis says that at "the end of July, 1847, I found in a field of Tares or Vetches (*Vicia sativa*), left for seed and partly ripe, a great number of the pods, which were more or less distorted. On opening them I found the seeds partially eaten, some with only a hole in them, surrounded by abundance of brown and white excrement; other seeds were hollowed out, and a cell formed in each of them of an oval form, but irregular; in these cells was either a fat maggot or a pale ochreous pupa, which I at once saw was that of some weevil. On

the 16th of August three specimens of *Apion pomonæ* hatched." These were at first of an ochreous colour, but eventually became black.*

These beetles are partly distinguishable from most of the other of our Apions by the peculiar shape of the proboscis, which is short, and thickened at the base; in fact, as Mr. Hamlin describes above, "a sharp snout similar to that of a mole." The figure on p. 134 conveys this and the projection of the eyes very fairly. The colour of both male and female black; length variable, sometimes nearly a quarter of an inch. The beetles fly readily, and especially frequent Whitethorn; also hedges, which agrees with Mr. Hamlin's observation that the infestation started from the hedgerows.

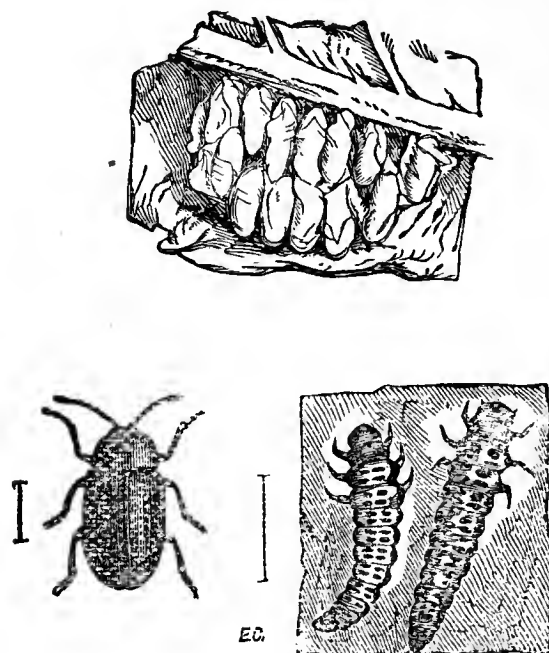


Deformed flower head of Tare, magnified. Drawn from specimens sent by Mr. Hamlin.

If the reader will compare John Curtis' figure, given at heading, of a Tare blossom head distorted by this infestation, and the figure drawn by myself from life, given above, he will see a remarkable similarity in method of attack; but still I do not find notes in any work I have at hand of this *Apion* infestation distorting the leaf stalk, which, as I have shown in my figure, was a noticeable point in the Lingfield specimens sent me. As this Tare attack is a very troublesome one, I have given all bearing on the subject which I have access to, though by no means thoroughly clearing up the matter, and shall be very glad of fuller information.

* 'Farm Insects,' by John Curtis, p. 488.

WILLOW.

Willow Beetle. *Phratora vitellinæ*, Linn.

PHRATORA VITELLINÆ.

Willow Beetle, caterpillars, and eggs, magnified; lines showing nat. length.

Willow Beetle attack was excessively injurious in the past season at various localities. About the middle of May I received the following account of the great damage that was being caused in their plantations by this infestation, from Messrs. W. T. Ellmore & Son, High Street, Leicester:—"We have a piece of Willow ground some 50 acres in extent, which is literally infested with them, to the detriment of the crop. Acres and acres of the crop were last year virtually destroyed with this pest, and we employed quite a small *host* of people with tins with paraffin in to catch them, and we were hoping that our efforts would have been rewarded by their absence this spring. In addition to what we caught last spring, in the autumn we put faggots all about our ground, made with reed and other tubular plants, pieces of bark and other rubbish, which were instrumental in collecting very many, and these we fired in the early months of the year; but during these last few days the beetles have come out almost in millions. We have now as many caught as will fill a good-sized bucket, by which you can judge how we are infested."

On June 10th, Mr. John Harrison, President of the Leicestershire Chamber of Agriculture, also notified to me that "we have now a trouble amongst the Willows, a large grower in this locality having suffered greatly."

On Aug. 24th, Mr. Weld Blundell, of Ince Blundell Hall, Blundellsands, Lancashire, enquired regarding a Willow Beetle which had destroyed all the Willows on his estate. Later on, on Oct. 26th,

application was made me by Mr. J. Mc'Kenzie, from the Inspector and Surveyor's Dept. of the Rural Sanitary Authority, Altrincham, Cheshire, regarding information to check, if possible, a serious blight which had visited Willows growing on one of their sewage farms.

The specimens forwarded showed the cause of mischief to be the Willow Beetle, and the following observations were sent :—"The crop of Willows (one year's growth) now growing on our Ashton-on-Mersey Willow Beds have been blighted with some sort of insect or fly, the whole crop turning quite yellow in the leaf in a very short space of time. It seemed to take whole of outer edge of crop first, and then travel inwards. The leaves turned yellow in the leaf and then dropped, and on examination we find the bark has even been eaten. All the Willows in the surrounding hedges and ditches are similarly affected. Willows growing on the Stretford Sewage Farm (2 miles away) were also affected, but one day they swarmed and went away in clouds, and have not since returned."—(J. Mc. D. Mc'Kenzie.)

On the 20th of Oct., the following note was sent, accompanied by specimens of injured shoots from Mr. J. M. Wilson, of Carrygrane, Edgeworthstown (Leinster, Ireland) :—"The enclosed are some pieces of osiers, taken promiscuously from a large bed which I have, and which this year has failed entirely. Perhaps you can inform me what is the cause?" This also, though beetles were not sent, appeared from the method, and also from the severe amount of injury to leafage, to be another case of damage from infestation of the Willow Beetle, the *Phratora vitellina*.

These beetles are of the shape figured at p. 138, with the natural length given by line accompanying, of a shiny greenish or bluish or bronze tint above, more brassy below. They shelter during winter in any convenient place, as under old bark of Willow or other trees, in rubbish on Willow grounds, in crevices of fences, &c.

From these they come out in spring, and begin the first attack somewhere about May. They lay their eggs on the surface of the leaf, and the pale

black-spotted grubs which hatch from these feed on the under side of the leafage, working right through until the upper film becomes so thin that it cracks or dries away, leaving the leaf in holes as figured.

This makes the second attack. Later on these maggots turn to chrysalids in the ground, from which the autumn brood of beetles comes up. These attack the leaves and young shoots, and do immense



Willow leaf partly eaten by Willow Beetle.

mischievous. Thus there are three definite attacks—that of the great mass of the summer or autumn beetles, which appear when the Willow growth is well advanced; another of these beetles, which come out again to forage on the new growths of Willow, after their own winter sleep; and the ravages of the grubs in the summer.

PREVENTION AND REMEDIES. — The preventive measures, as is obvious, lie in removing, so far as can be done, all winter shelters where the beetles could resort to for protection. This must make some difference; and also *abstaining* from making large collections of rubbish, as of Willow peelings, &c., and leaving them to decay, or using them (as I have seen done in the case of the peelings) to form a kind of rough thatch to sheds, must certainly prevent the attack being as bad as it would otherwise have been. But these measures have proved, as we know, very insufficient.

We are in the same position here regarding plant growth that we are in regarding orchard growth in fruit farming. We have large areas—a good many acres, that is to say—of plant crop growing on, year after year, on the same ground. Direct remedy—something to be applied to get rid of the infestation (if it be possible) when it appears—is what we want.

In a very bad attack, in 1884, to Willow beds at Lymm, Warrington, and other places on the border of Lancashire and Cheshire, regarding which I had much correspondence, Mr. Cameron, writing from Lymm on the 29th of May, reported as follows:—"The remedies hitherto tried (but so far with little success) are dusting the young shoots with hellebore powder, soot, sulphur, lime, and spent gas-lime. *The plan now adopted is to hand-pick, or rather shake off, the insects into small vessels containing a small quantity of paraffin oil.* This plan has been steadily carried on by many of the Willow growers during the last fortnight *with marked success*; but unfortunately a few people take little or no notice, and I fear these neglected lots will pollute the surroundings."

In the past season of 1890, Messrs. Ellmore, writing to me on the 29th of May, further confirmed the above report by mentioning as follows:—"We have frequently been in communication with an old friend of ours, Mr. Hutchinson, of Warrington, who is an important Willow worker and grower." He said that "his experience led him to think the best remedy was in picking them off by hand, and placing in tins containing a small quantity of paraffin. That is the course we have pursued, and fifteen men have been employed doing this, and have caught endless quantities. In fact, we have caught as many beetles as would fill a fair-sized bucket."

In the experiments undertaken at my suggestion in 1884, we found

that Paris-green gave some good results, and I should certainly think that, with the great increase in knowledge that we have since then of *how* to apply this chemical, of the proportions in which it is to be used for delicate leafage, how to mix it with flour, and, further, the feasibility of obtaining conveniently portable knapsack sprayers with nozzles which will distribute the fluid properly in the form of fine spray, this remedy would be very likely indeed to be of service.

Looking at notes of success and also of difficulties to be met in 1884, I find that Mr. G. H. Leigh, a Willow grower at Lymm, mentioned that, having tried the application of soot and also of hellebore without any success, he then tried Paris-green, with about half an ounce to three to four gallons of water. The Willows by this time were grown three feet high; therefore he could not apply a good spray; but the application to the plants on the compass of ground sprayed with Paris-green *was successful*. It scorched the leaves a *little*, and made them curl, which he believed was the cause of the beetle removing itself; but "it did not injure the main shoot." Also, it is noted, "I cannot say it killed the beetle right out, as it immediately dropped to the ground, being always on the alert when anything touched the leaves."

Mr. Leigh added:—"I am also of opinion that Paris-green, if used early, would prevent, if not completely destroy, them; and if it was more used with a good spray it would destroy it in the early stage."

At the conclusion of the reports of the summer the Paris-green had been most satisfactory of all the dressings which had been tried, and Mr. Cameron remarked:—"Indeed, I *believe by applying this dressing* early enough the beetle might be kept fairly well under, the difficulty at this season of the year being to get the wash distributed; the Willows grow so thickly on the ground, and so high, that any spray distributed cannot be used."

The different points were given in detail in my Report on Injurious Insects of 1884, published in 1885; but if the reader will just look over the notes given above, in the light thrown by the experiments of our Evesham Fruit Conference Committee during 1890, it will be seen that the difficulties we met with in 1884 can be coped with now.

The proportion mentioned above is $\frac{1}{2}$ oz. of Paris-green to three or four gallons of water. This is stronger than what we advise. 1 oz. of Paris-green to ten gallons of water for Plum leafage, and 1 oz. to twenty gallons of water for Apple leafage, is the strongest proportion that we recommend.

With regard to killing the beetle. — The application does not kill by contact, but by poisoning the food. Therefore the application should on *no account* whatever be sent vigorously, like a rain-storm (as I have reason to believe has sometimes been done), at the infested plants, for

in this case it only knocks or frightens the beetle out of the way of what is meant gradually to kill it. It should be sent as a spray, to rest like a dew evenly all over the surfaces of the leafage, so that, unless the beetle flies elsewhere, it has no resource but to eat the poisoned food; and if the spraying is as complete as it should be, the dew will rest on the under as well as the upper surface of the leaves, and avail in destroying the grubs as well as the beetles.

Another point mentioned as a difficulty was "the Willows by this time were grown three feet high; therefore he could not apply a good spray; but the application to the plants on the compass of ground sprayed with Paris-green was successful."

By means of the knapsack sprayer, which was successfully used at the Toddington Fruit Ground last year, the spray can be sent to a height of fourteen or fifteen feet, and properly distributed."*

So far as the more practical work of application of the Paris-green is concerned, it will be seen that the above notes of advance in information, since our experiments of 1884 were tried, will meet the difficulties which then encumbered us. Looking at the amount of success which we then had, and also considering that Paris-green is *the* especially approved application in America, and has been so for many years, and over thousands of miles, for keeping down the Colorado Potato Beetle (which, being one of the *Chrysomelidæ*, is very nearly allied to our Willow Beetle),—these points appear to suggest forcibly that it would be well worth while to try again, with the lesser strength and the better spraying machines, whether we could not get rid of the Willow pest when it appears.

All the requisite *cautions* to be considered in the use of Paris-green, it being arsenite of copper and consequently a poison, and all requisite instructions as to methods of use, are given in the preceding pages, under the head of Paris-green; also notes of another arsenical insecticide, "arsenite of lime," sold under the name of London-purple, in the use of which similar *precautions* and methods of application are to be observed. It should, however, be always borne in mind that for safety to leafage, in the case of insecticides of which the effect is not wholly known to the applier, experiment should be made on a small scale to a few trees or plants, and the results watched for a few days, and their effect ascertained beyond all doubt, before proceeding to try them on a scale that may at hap-hazard greatly benefit, or greatly injure, acres of tree or plant growth.

* Information regarding this form of spraying machine will be found at p. 99 preceding, under the heading of Paris-green.

INDEX.

Alum, not serviceable for destroying caterpillars, 85
 American blight, 1—4
 Ammonia, sulphate of, 20
 Anisopteryx æscularia, 77
 Anthomyia betæ, 72
 Anthonomus pomorum, 11
 Aphelenchus fragariæ, 126, 130
 Aphis, Woolly, 1—4
 Apion apricans, fig., 27; pomonæ, 134
 Apple, 1—15
 Apple-bark Beetle, 124
 Apple-blossom Weevil, 11—15; damage from, 13; dates of appearance of, 14; powers of flight of, 12
 Apple Chermes, 4—11; history of, 6—9
 Apple-sucker, 4—11
 Arsenite of copper, 97; lime, 104

 Beans, 16—21; Stem Eelworm in, 16—21; effect of infestation on, 17, 19
 Bos, Dr. J. Ritzema, on "Cauliflower disease" in Strawberry plants, 126
 Boulton & Paul's sprayer, 101
 Burford's soft-soap and sulphur compound, 3

 "Cauliflower disease" in Strawberry plants, 126—133; description of figs. of, 127; description of, 128, 130—132; Eelworm of, 130
 Cecidomyia destructor, 32; legumini-cola, 23—27; description of, 25; maggots may be found amongst Clover-seed, 26
 Cecidomyia in Tares, 135
 Cheimatobia brumata, 74
 Chlorine fumes, to prepare, 59
 Chlorops tæniopus, 28
 Chortophila betæ, 72
 Clover-seed Midge (American), 23—27
 Corn and Grass, 28—52

 Dot Moth, 61—64; caterpillar injurious to Gooseberry and Currant leaves, 61; description of caterpillar, 61, 62; food plants of, 62

 Emerald-green, 83 (see Paris-green)
 Ephestia kühniella, 52
 Evesham Moth, 74
 Experimental Committee, Evesham, 84, 85

Figure-of-8 Moth, 77
 Flour Mills and Stores, 52—60
 Flour Moth, Mediterranean, 52—60; gradual spread of attack, 53, 54; description of caterpillar of, 54,—of method of infestation, 55; remedial measures for, 56, 57; sulphur, to prepare fumes of, 58; proper proportion to use, 58; chlorine, to prepare fumes of, 59; soft-soap and mineral-oil mixtures, 60

 Gastrophilus equi, 64
 Gooseberry, 61—64
 Gout Fly, 28—31; maggot of in young Wheat, 30; early sowing as a preventive of attack in Barley, 31
 Grease-banding, 81, 82; kinds of, 82

 Hay Mites, 40, 45
 Hay ropes (greased) to stop caterpillar progress, 82, 83
 Hessian Fly, 32—39; reports of from various localities, 32—36; estimates of injury from, 36; importance of destroying infested screenings, 37, 38; winter attack not as yet reported, 38; description of appearance of, 39
 Horse, 64—71
 Horse Bee, 64
 Horse Bot Fly, 64—71; description of, 65, 66; history of, 66—68; situation of Bots in Horse's stomach, 69—71
 Hylemyia coarctata, 49
 Hylesinus piniperda, 113
 Hylurgus piniperda, 113
 Hypoderma bovis, 106

 Iron, sulphate of, 20

 Knapsack sprayer, 99, 100

 Lackey Moth, 77
 Larch attacked by "Pine Beetle," 113—118
 "L'Eclair" sprayer, 99, 100
 London-purple, 104—106; analysis of, 104; variations in strength of, 105
 Lophyrus rufus, 118

 Mamestra persicariæ, 61
 Mangolds, 72, 73
 Mangold Fly, 72, 73; nitrate of soda beneficial after attack of, 73

- March Moth, 76, 77; eggs, date of laying, 76
- Mites (in Hay), 40—45; description of, 41; description of infestations of, 42, 44; letter of Mr. Albert Michael on, 43
- Moth caterpillars (orchard), 74—106
- Moths, orchard, names of different kinds observed, 77
- Mottled Umber Moth, 77
- Nippers, long-handled hawk-bill, for cutting bark twigs, 80
- Nitrate of soda beneficial after attack of Mangold leaf maggot, 73
- Orchard Moth caterpillars, 74—106; sticky-banding to prevent, 81; tar unsafe, 81; grease, different kinds of, 82; greased hay ropes successful, 82, 83; applications not useful to destroy, 85; Paris-green, 83—104; London-purple, 104—106
- Orgyia antiqua*, 78
- Ox Warble, 106—112
- Paraffin, 140
- Paris-green, 83—104; proportions found useful, 86, 89; non-success in killing Aphides, and reason, 87; success with in killing moth caterpillars, 88; method of application of spray, 90; animals not to be fed under sprayed trees, 91; special notes regarding, 94, 95; nature of, 96, 97; analysis of, 97; cautions as to use of, 97, 98; spraying machines, 99—102; to mix for spraying with, 102, 103; to mix flour with, 103, 104
- Phratora vitellinæ*, 138
- Pine, 113—124
- Pine Beetle, 113—118; attack of to Larch, 114—117
- Pine Sawfly (Fox-coloured), 118—121; history of, 120
- Plum, 124
- Potash, sulphate of, 20
- Psylla mali*, 4
- Ribbon-footed Corn Fly, 28—31
- Schizoneura lanigera*, 1
- Shot-borer Beetle, 124, 125
- Sirex gigas*, 122
- Sirex*, Giant, 122—124; observations of in Ireland, 122; colour of males of, 122
- Small Ermine Moth, 77
- Soft-soap, 3; and mineral oil mixtures, 60
- Somerville, Dr. W., observations of attack of Pine Beetle to Larch, 113—118
- Spraying machines, 99—102
- Steam, application of, as a remedy for Mediterranean Flour Moth attack, 56
- Stem Eelworm in Bean plants, 16—21; in Clover, 21—22; in Tulip-rooted Oats, 46—48; remedies for, 20
- Steven Lectureship, v (Preface)
- Sticky-banding, 81, 82
- Strawberry, 126—133
- Strawsonizer, 102
- Sulphur, damage from over-application of, 58; fumes, how to prepare, 58, 59
- Tar unsafe to apply to bark, 81
- Tare Cecidomyia, 135, 136
- Tare Weevil, 134, 137
- Tares, 134—137; distorted growth of, 134, 137
- "Tulip root," 46—48; kind of manure beneficial to prevent, 47
- Tylenchus devastatrix*, 16—22, 46—48; plate with figures of, to face p. 48; explanation of plate, 48
- Tyroglyphidæ, characteristics of, 41
- Tyroglyphus longior*, 40
- Vapourer Moth (Common), 78—80; caterpillars, description of, 78; cocoons, egg deposit on, 78, 80; fig. of, 79; nippers, long-handled, for cutting off, 80
- Vermorel nozzle, 100
- Warble (Ox), 106—112; "licked beef" caused by, 108; benefit from clearing maggots, 110
- Weevil, Apple-blossom, 11—15; Clover, Pear-shaped, 27; Tare, 134, 137
- Wheat-bulb Fly, 49—52; estimate of loss from, 51
- Willow, 138—142
- Willow Beetle, 138—142; damage caused by, 138, 139; remedies for, 140; Paris-green to destroy, 141
- Winter Moth, 74—76; egg, description of, 74—76; transportation of wingless females by their winged mates, 76; dates of appearance of, 83
- Wood Wasp, 122
- Xyleborus dispar*, 124

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